

News from a Warming Planet

Challenges and Opportunities for the State of Wisconsin

Prof. Jon Foley

Director, Center for Sustainability and the Global Environment (SAGE)

Gaylord Nelson Institute for Environmental Studies
University of Wisconsin, Madison



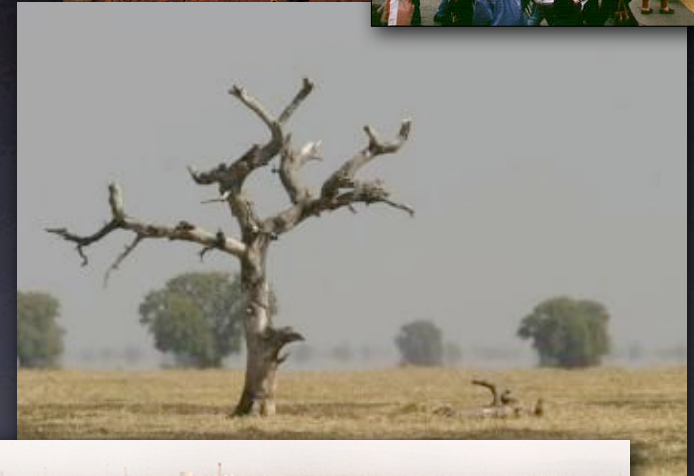
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Recent History...



Acceleration of History...

- between 1950 and 2000...
 - *population more than doubled*
 - *economy grew seven-fold*
- increasing agriculture
 - *food consumption almost tripled*
 - *water use roughly tripled*
- and energy use
 - *fossil fuel use increased four-fold*

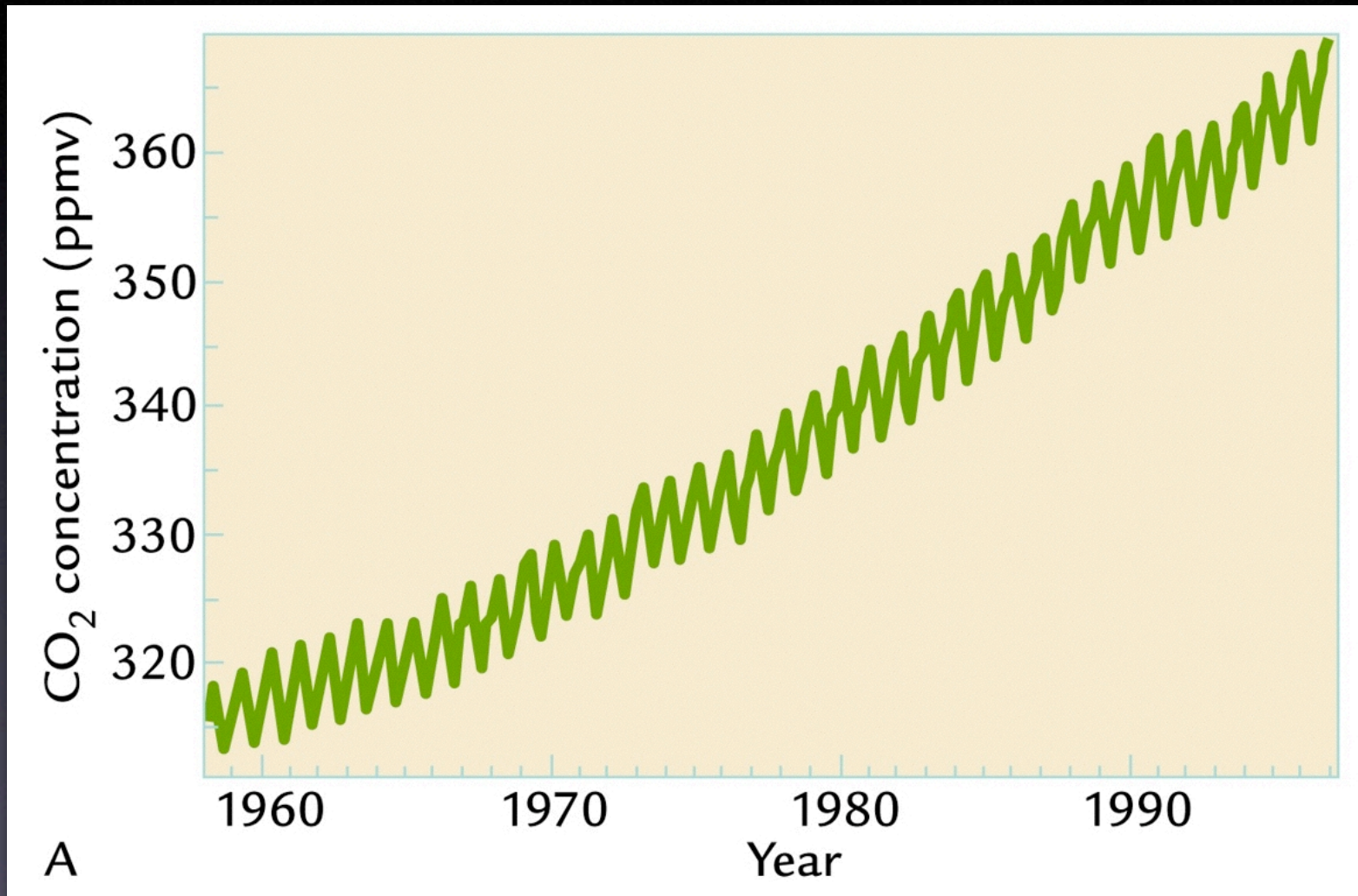


The Planet has Noticed...

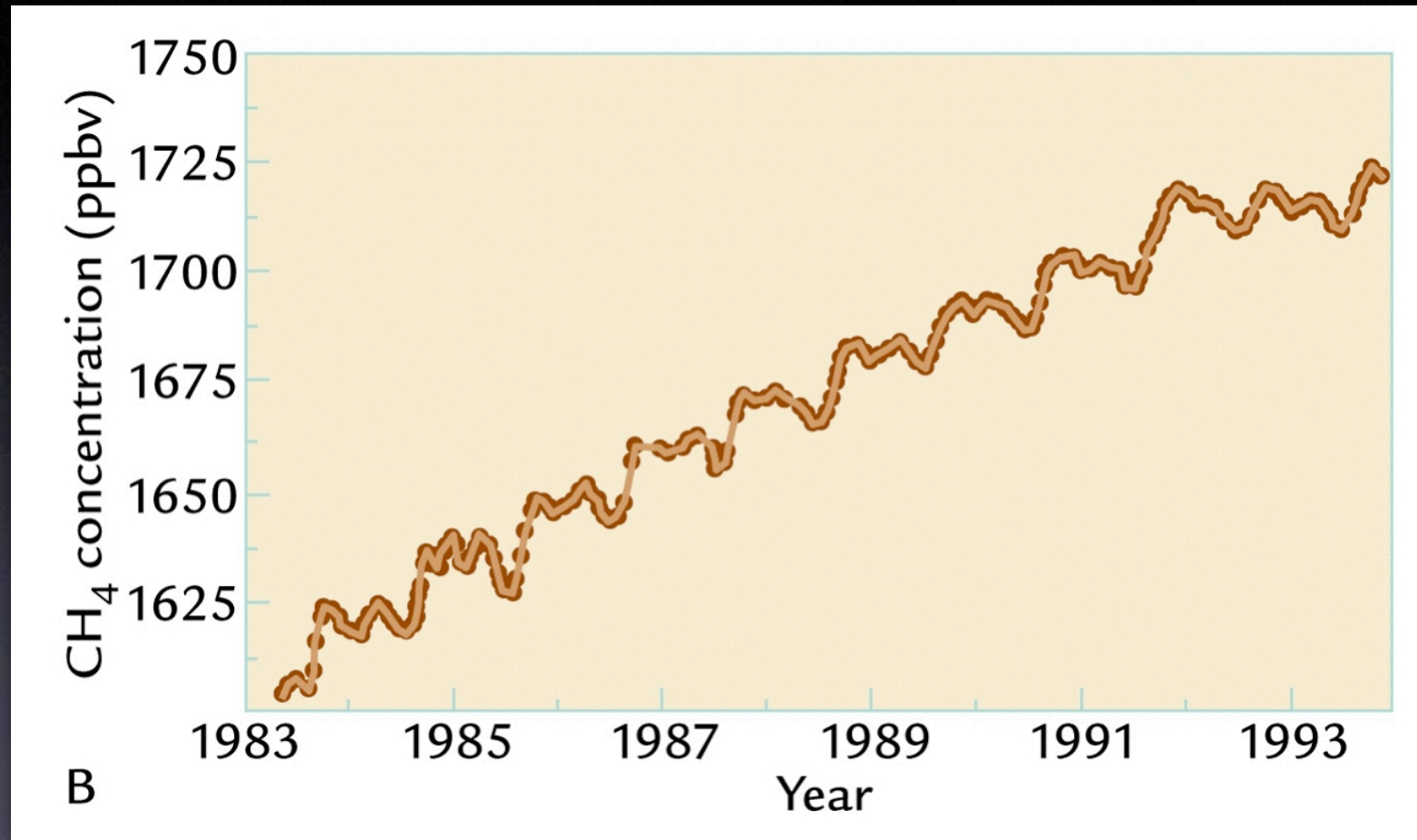


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Increasing Carbon Dioxide



Increasing Methane



A Warming Planet



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Image: Apple

You've Heard This Before...

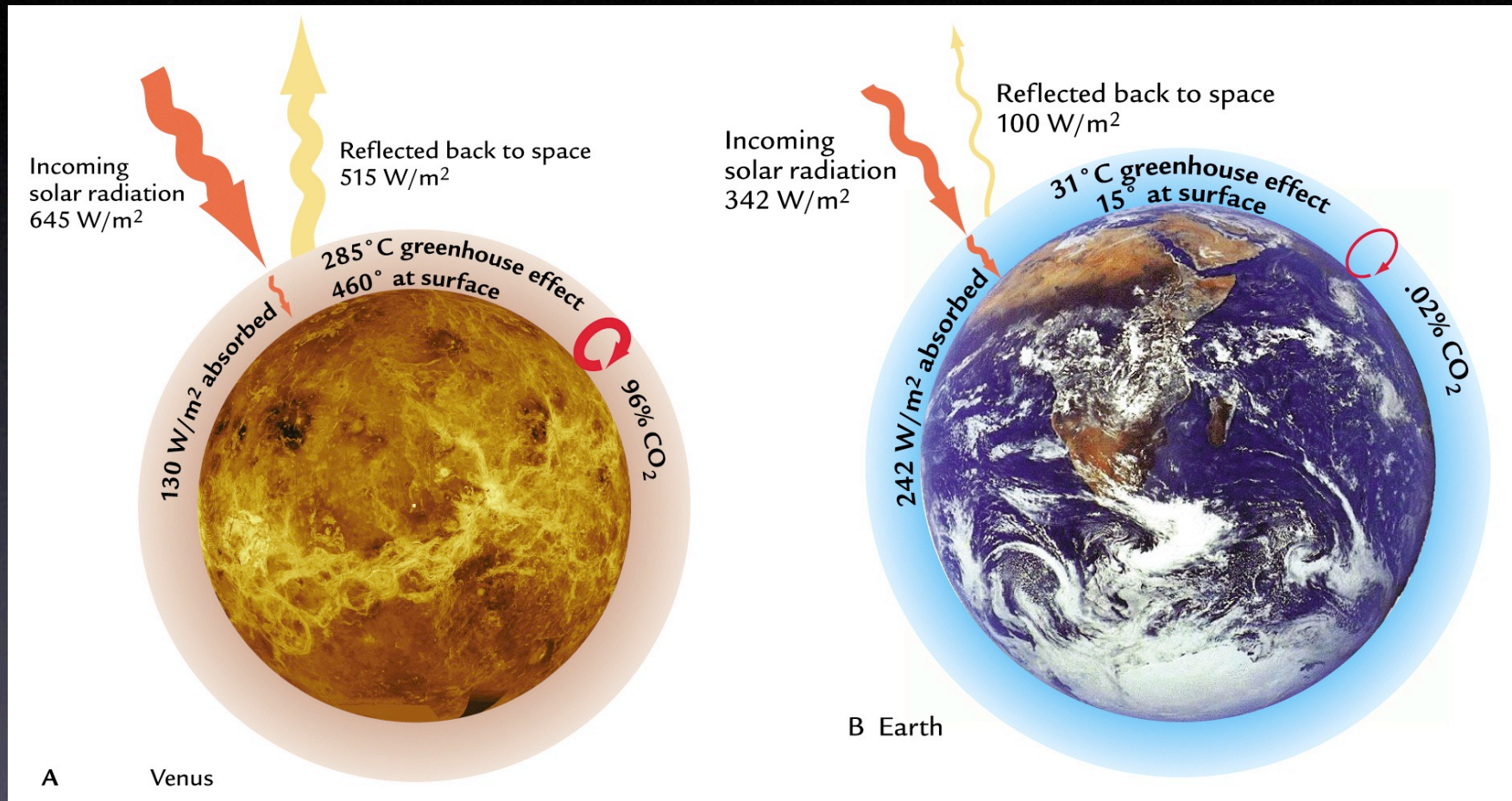


It's Just Physics 101



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A Tale of Two Planets



This is *Not* a New Idea



Svante Arrhenius



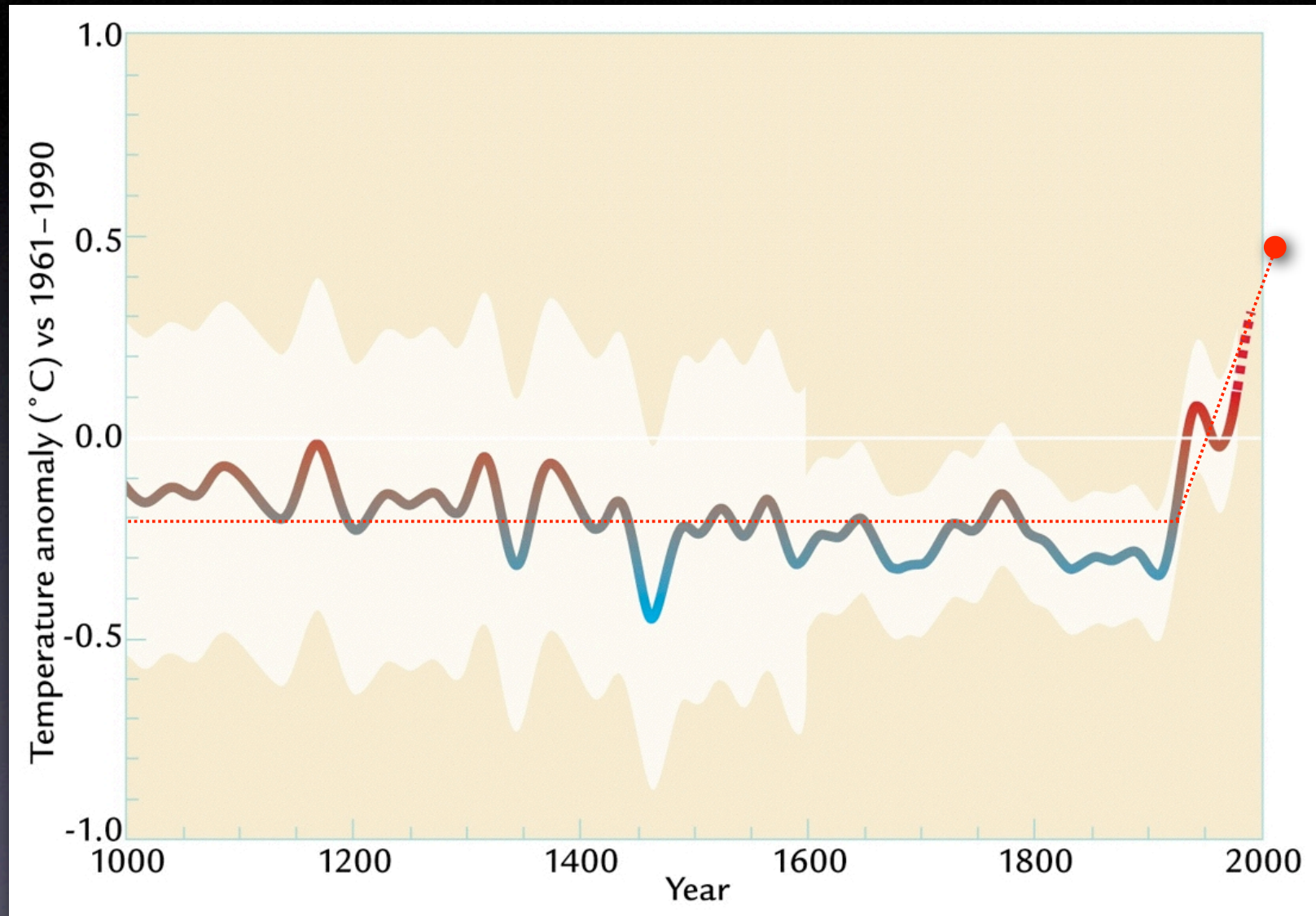
T.C. Chamberlain



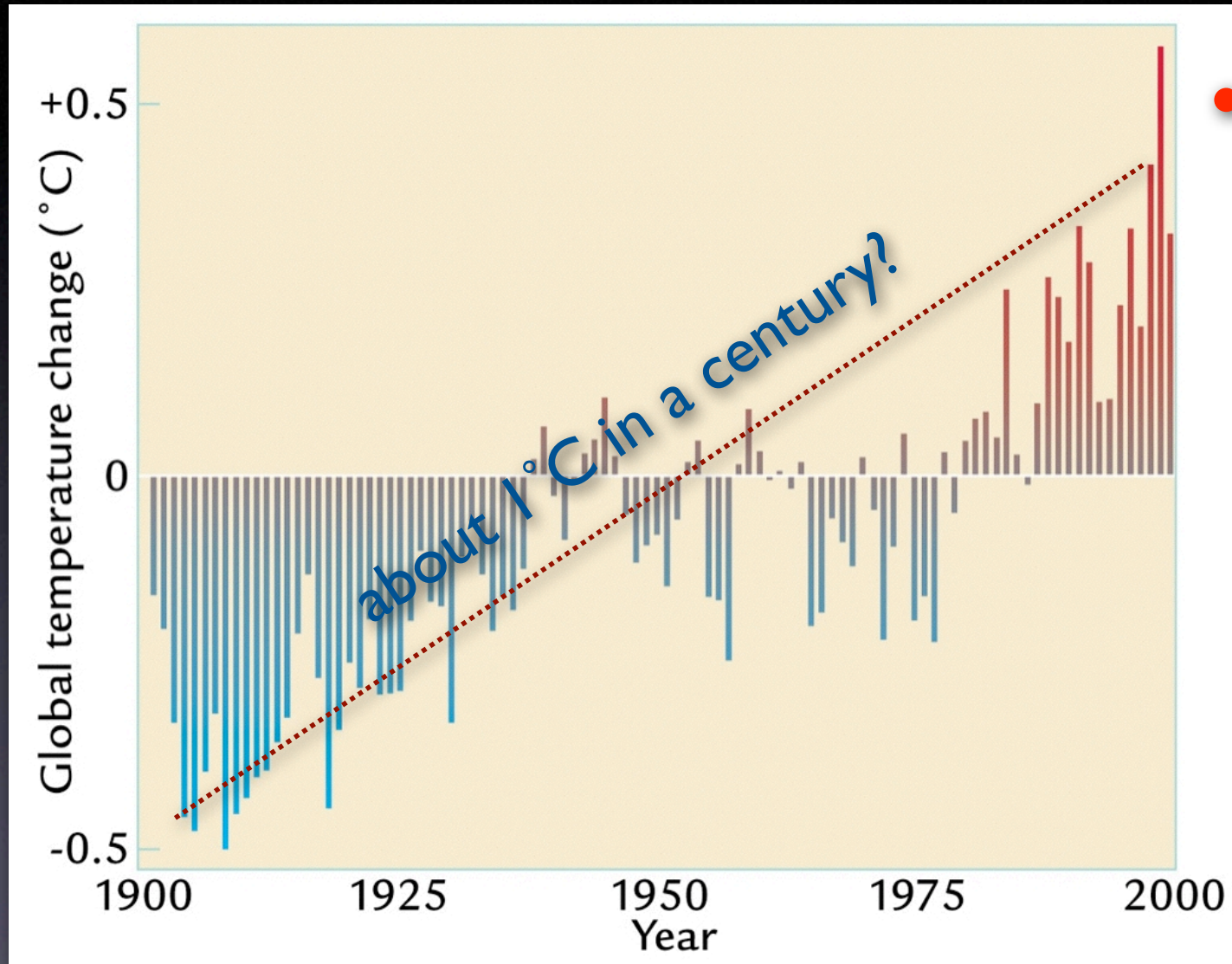
The Data



2nd Millennium Climate Record



20th Century Warming



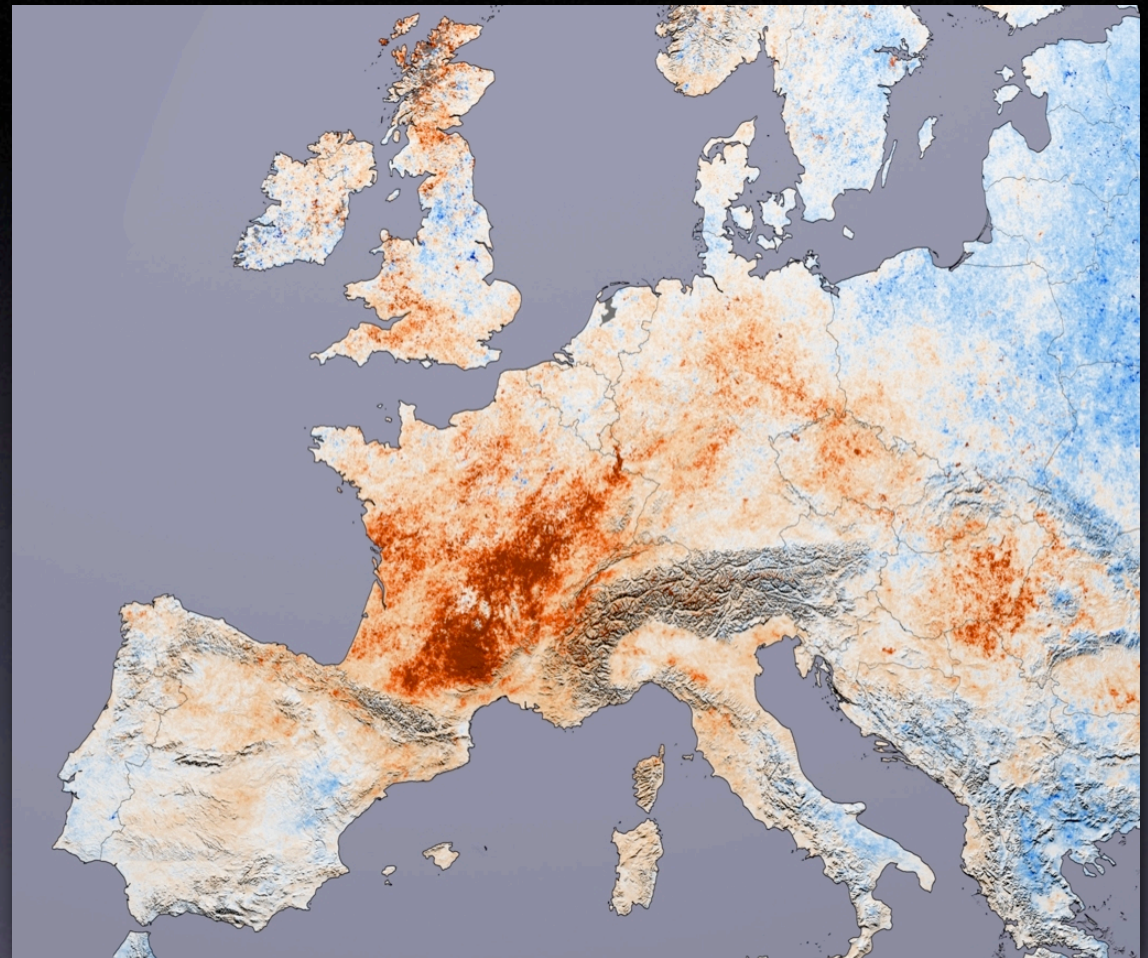
Hottest Years on Record



Regional Warming

- Europe 2003

Country	Death Toll
France	15,000
Netherlands	1,400
Portugal	1,300
Italy	20,000
UK	900
Spain	100



Temperature anomaly (C°)



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Image: Gore

Regional Warming

- Eastern U.S. 2005

June 23, 2005 La Crosse, WI hit 98° F

July 25, 2005, New Orleans hit 98° F

July 26, 2005, Florence, SC hit 101° F

July 26, 2005, Raleigh-Durham, NC hit 101° F

July 27, 2005, Newark, NJ hit 101° F



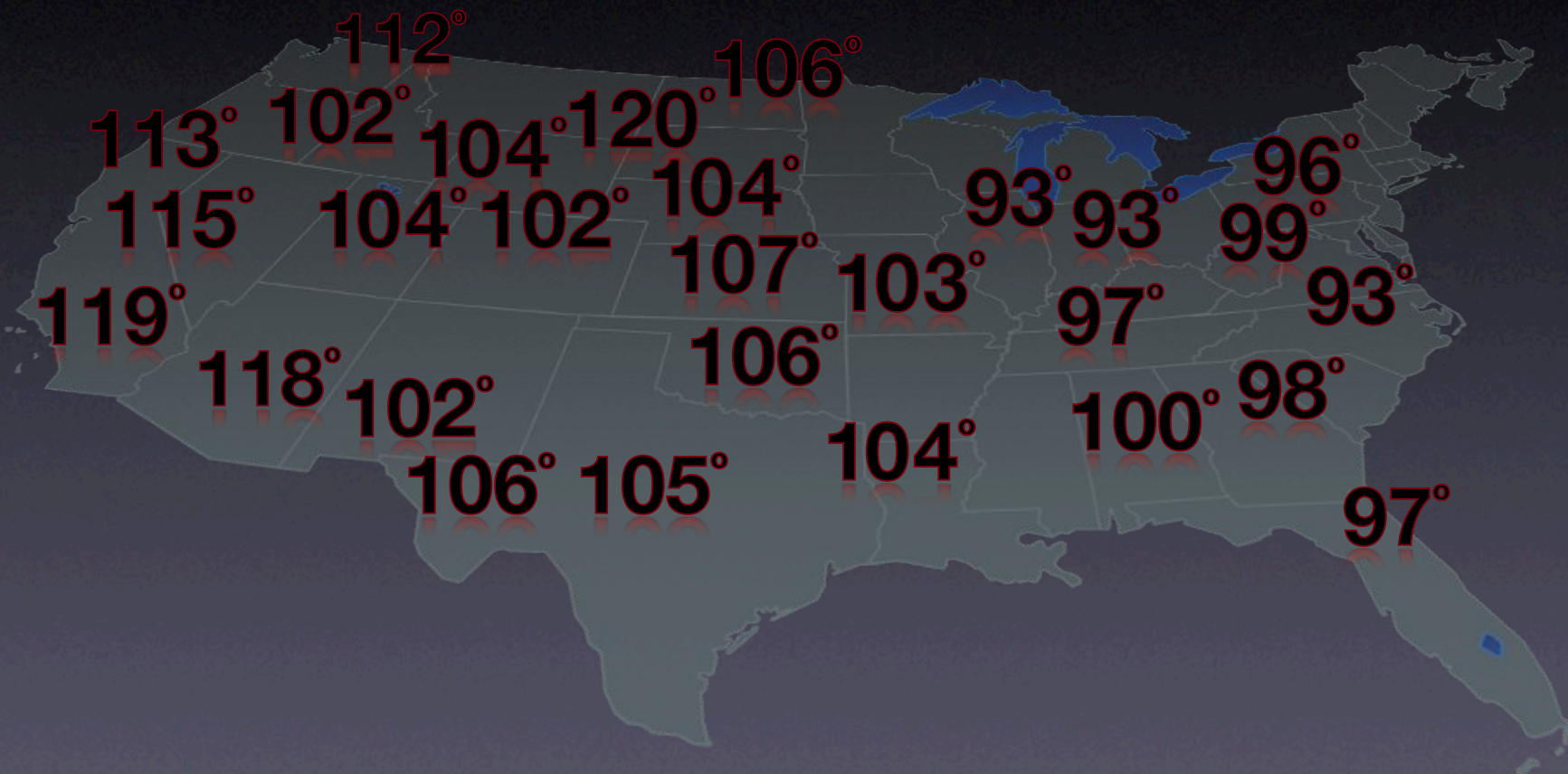
Regional Warming

- Europe, Summer 2006



Regional Warming

- U.S., July 2006



Regional Warming

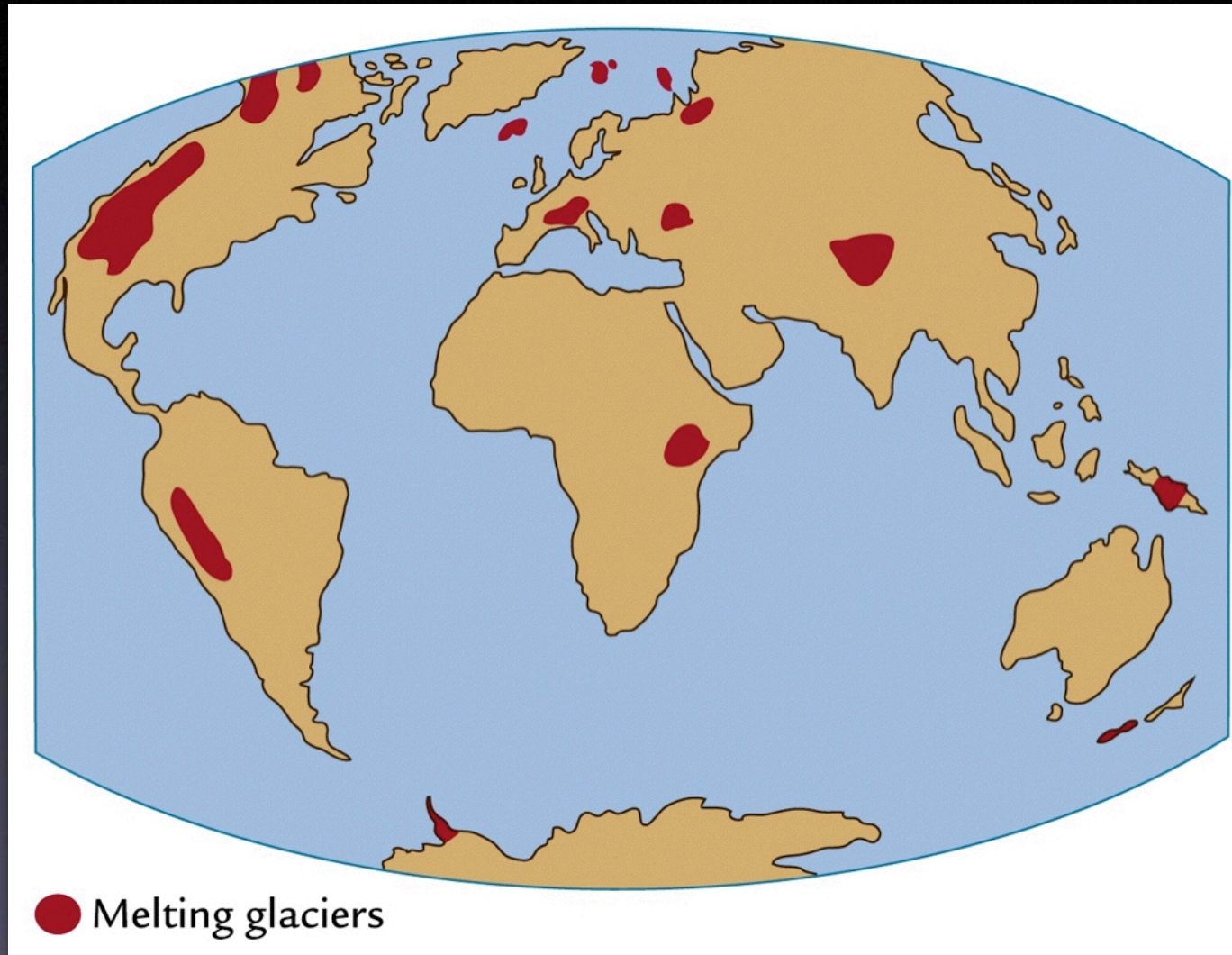
- U.S. 2005-06



Other Evidence



Other Evidence: Glaciers?



1941



Muir Glacier, Alaska

2004



Online glacier photograph database.
Boulder, CO: National Snow and Ice
Data Center/World Data Center for
Glaciology. Digital media.



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1909



Holgate Glacier, Alaska

2004

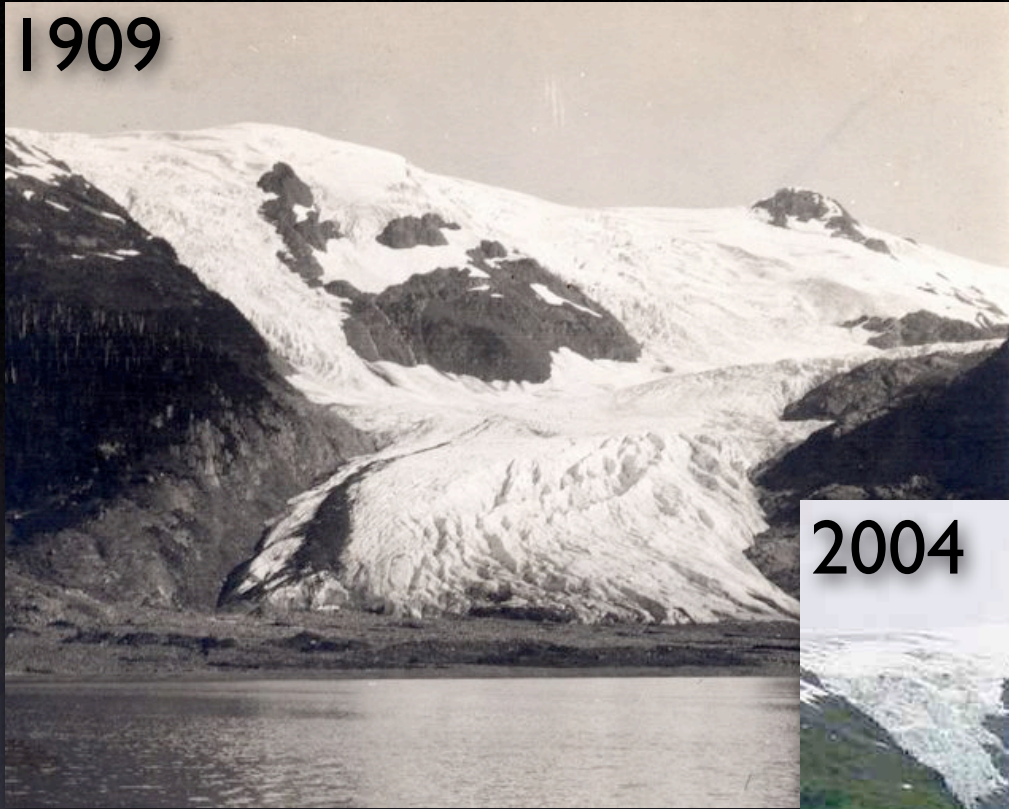


Online glacier photograph database.
Boulder, CO: National Snow and Ice
Data Center/World Data Center for
Glaciology. Digital media.



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1909



Toboggan Glacier, Alaska

2004

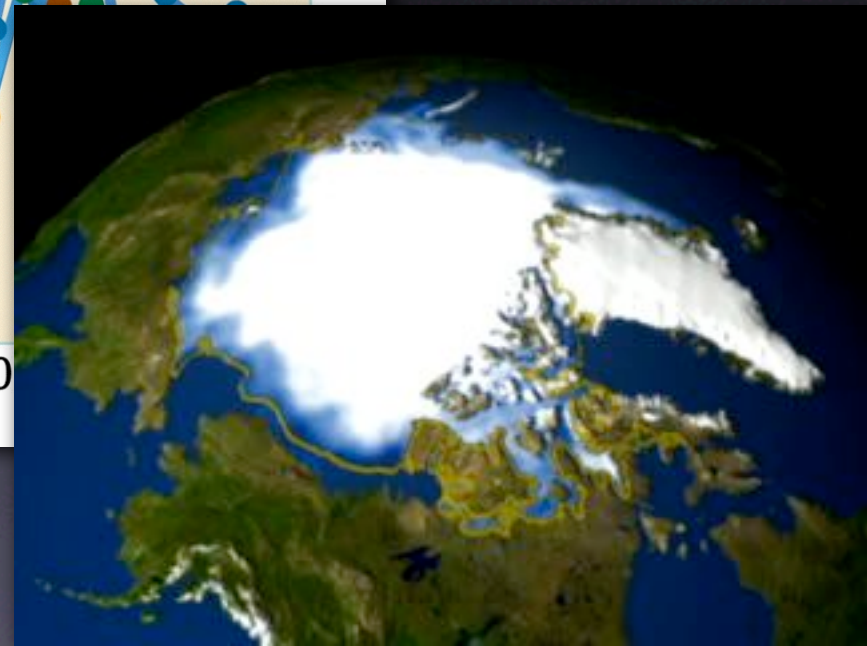
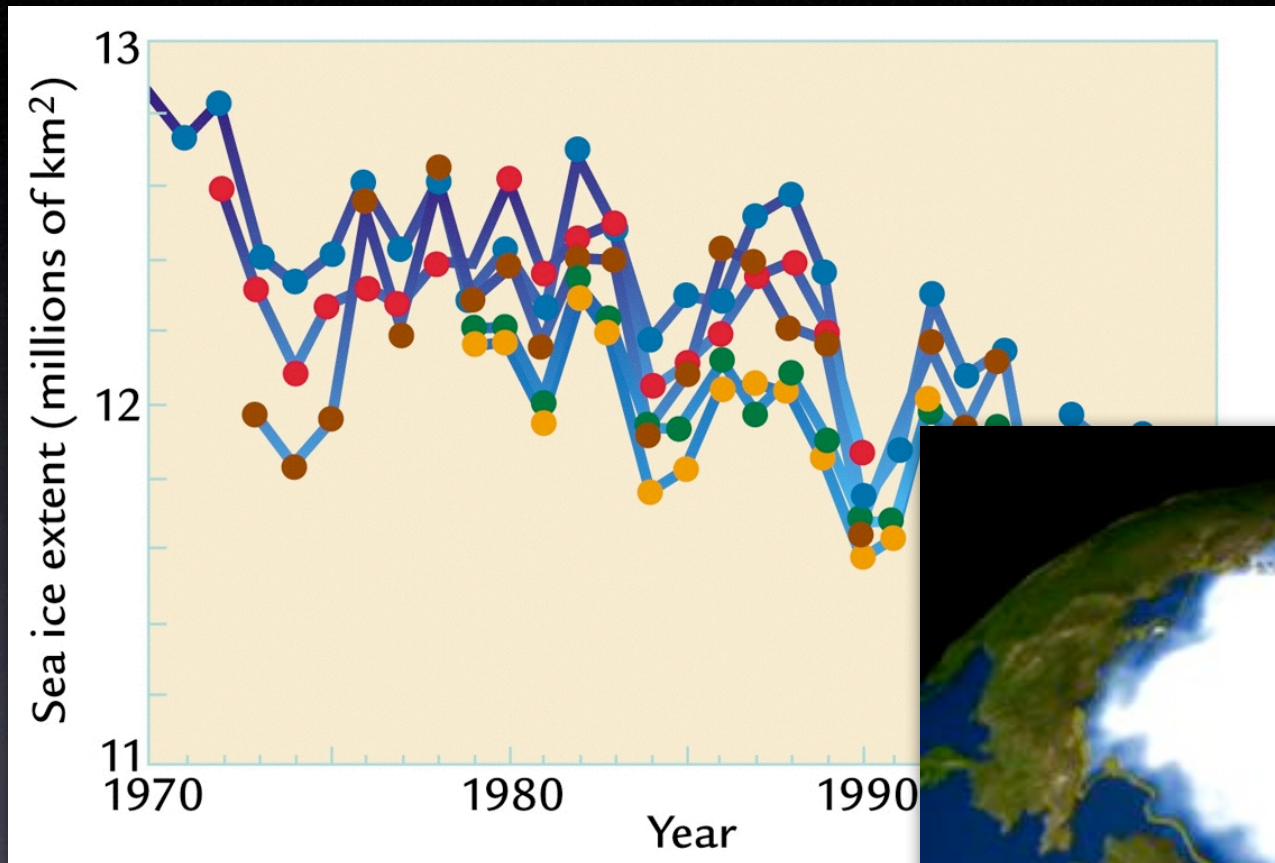


Online glacier photograph database.
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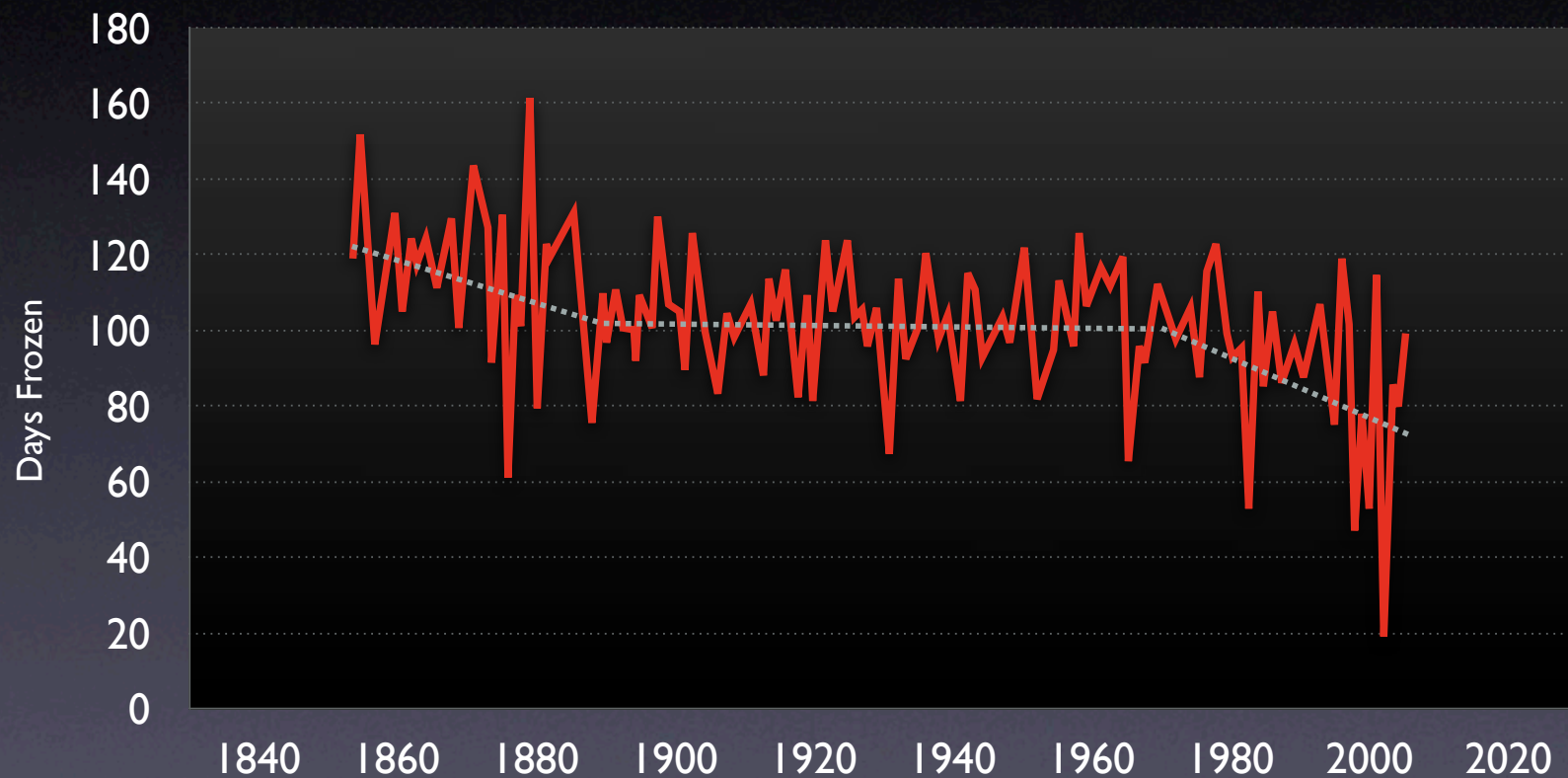
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Other Evidence: Sea Ice

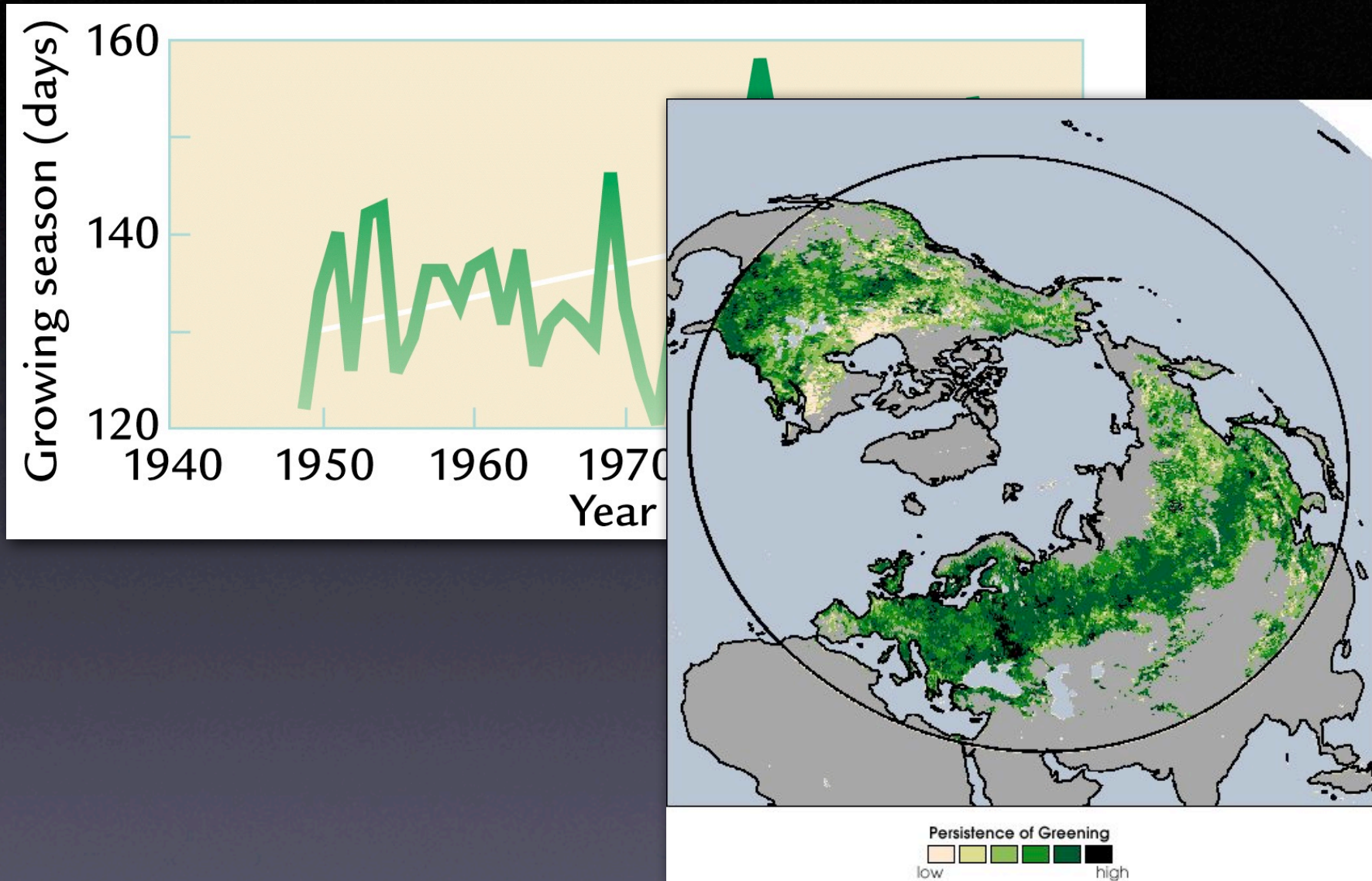


Other Evidence: Lake-Ice

Lake Mendota, Wisconsin



Other Evidence: Seasons



But Myths Persist



“Well, It’s Just a Theory”

- actually, this is right
- but a theory is not a “guess”
 - *that’s a hypothesis*
- a theory fits all of the available data
- other “theories”
 - *gravity*
 - *earth is round*
 - *earth goes around the sun*



“The Scientists Aren’t Sure”

- absolutely not true
- recent analysis of scientific data (Oreskes, 2004)
 - 928 peer-reviewed papers: evidence for human-induced warming
 - 0 showed otherwise
- all international scientific organizations agree
 - IPCC, U.S. NAS, AMS, AGU, AAAS, etc...
- handful of professional “skeptics” -- that’s all



“It’s a Left-Wing Eco-Conspiracy!”



A Real Human Dilemma

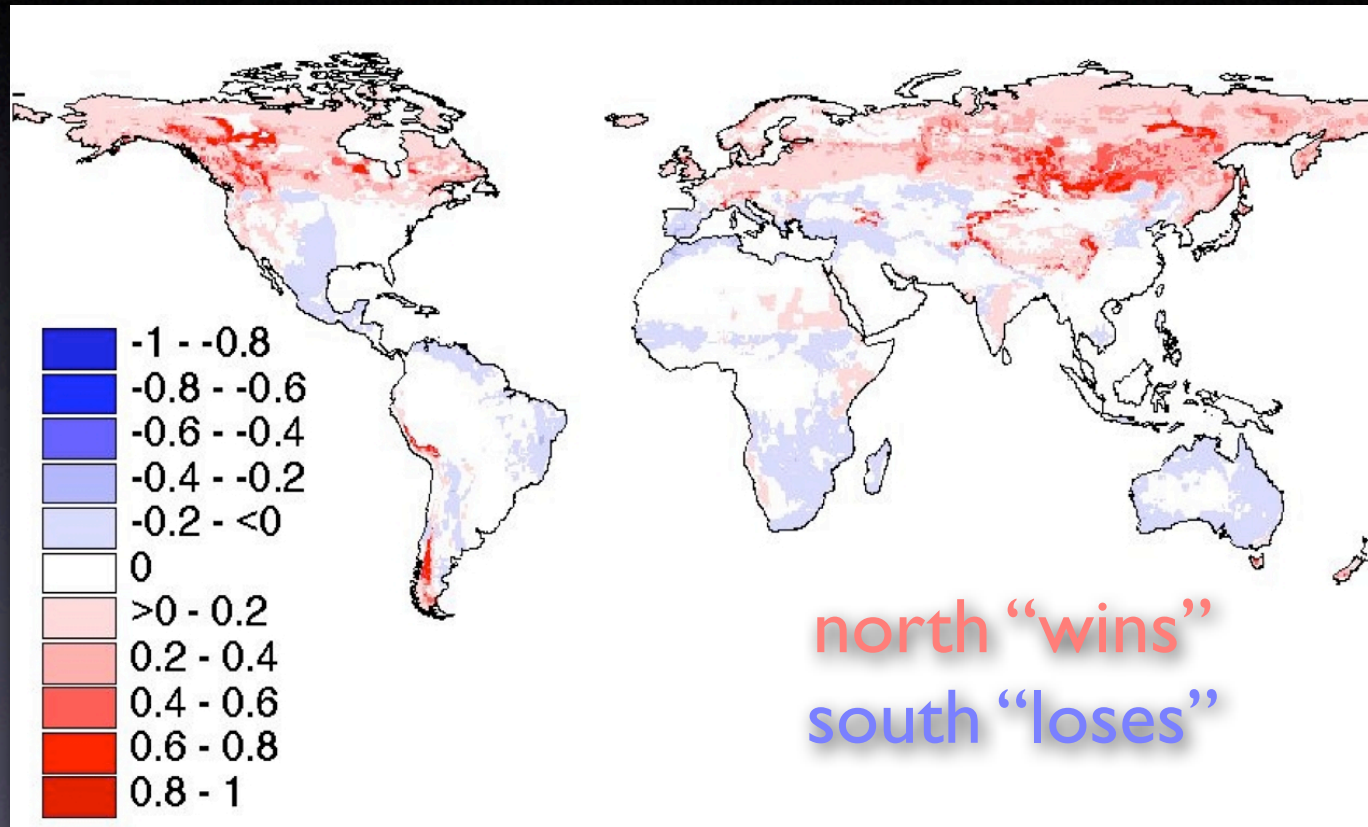


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Image: Apple

Food Security Impacts

- future changes in agricultural production?



Source: Ramankutty et al., 2002

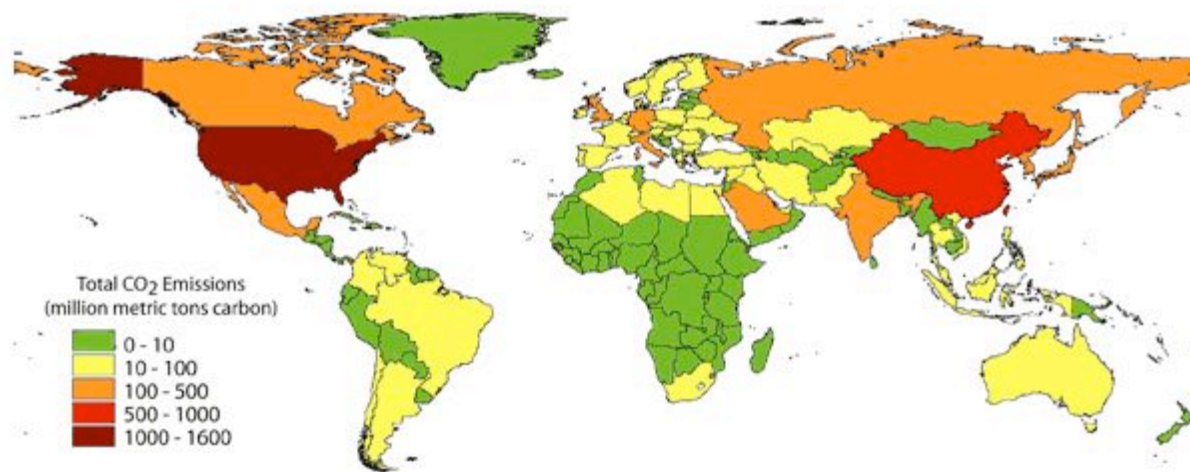


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Health Impacts -- Today

~150,000 deaths / year....right now

Total CO₂ Greenhouse Gas Emissions in the Year 2000, by Country



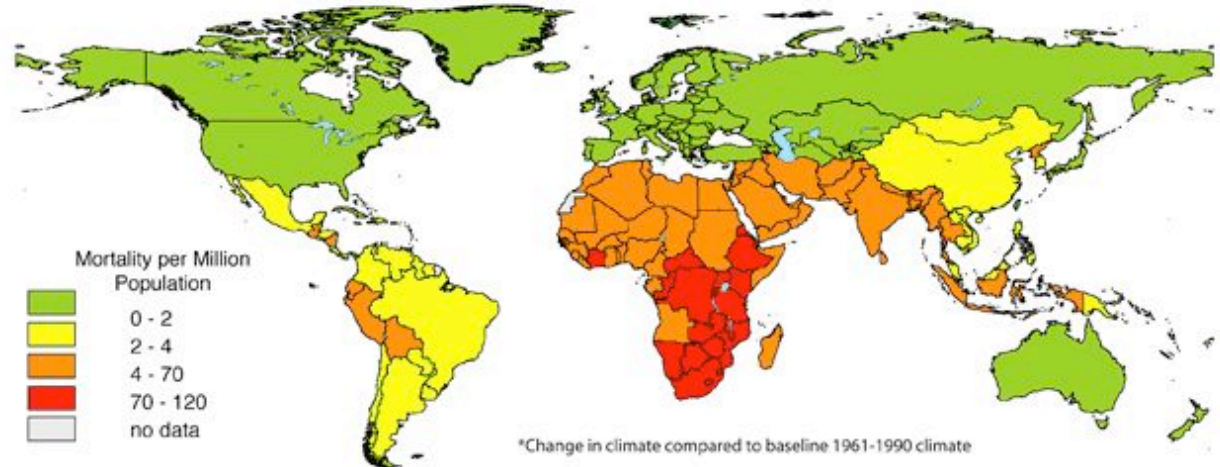
Data Source:
Marland, G., T.A. Boden, and R. J. Andres. 2003. Global, Regional, and National Fossil Fuel Combustion Emissions. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy.



Maps produced by the Center for Sustainability and the Global Environment

Image: Patz et al., Nature, 2005

Estimated Deaths Attributed to Climate Change in the Year 2000, by Subregion*




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Those Hardest Hit

- sensitive regions
 - *Arctic, coral reefs, tropical countries, small island nations, ...*
- major irony: *these people emit little pollution!*
- security issue
 - *massive destabilization*
 - *refugees*
- moral issue
 - *equity, ethics*





Unlike Any Environmental Problem We've Faced Before



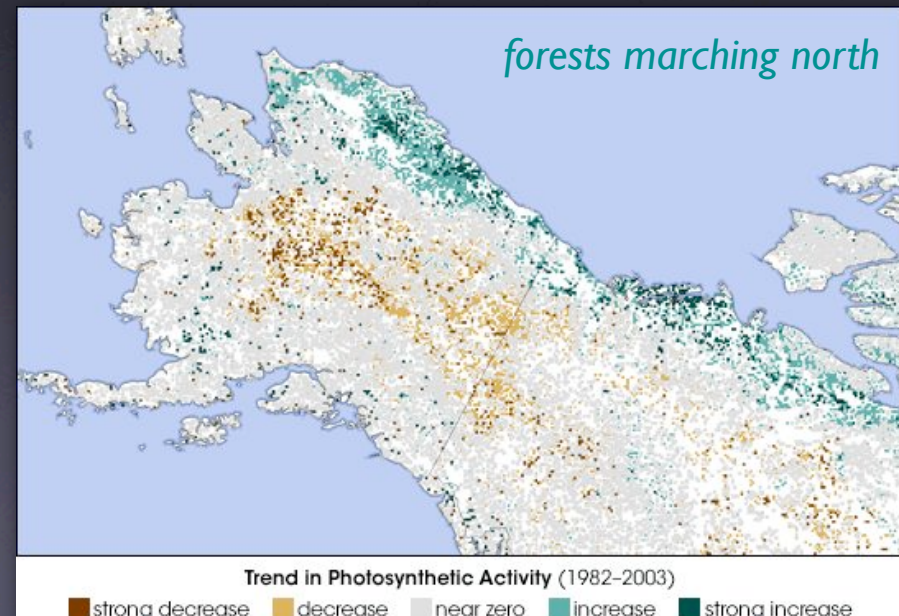
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Image: NASA

37

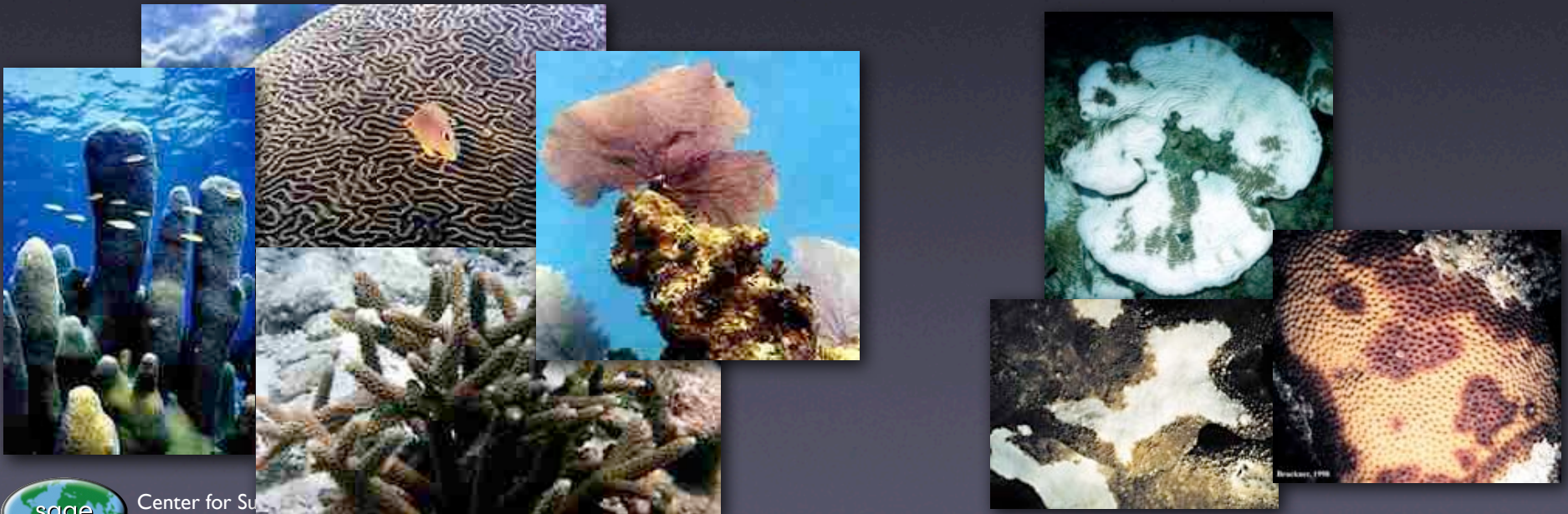
Arctic Ecosystems

- already seeing strong warming
- shrubs, forests marching north
- darker surface, more warming: *nasty feedback!*
- *Arctic systems at a tipping point?*



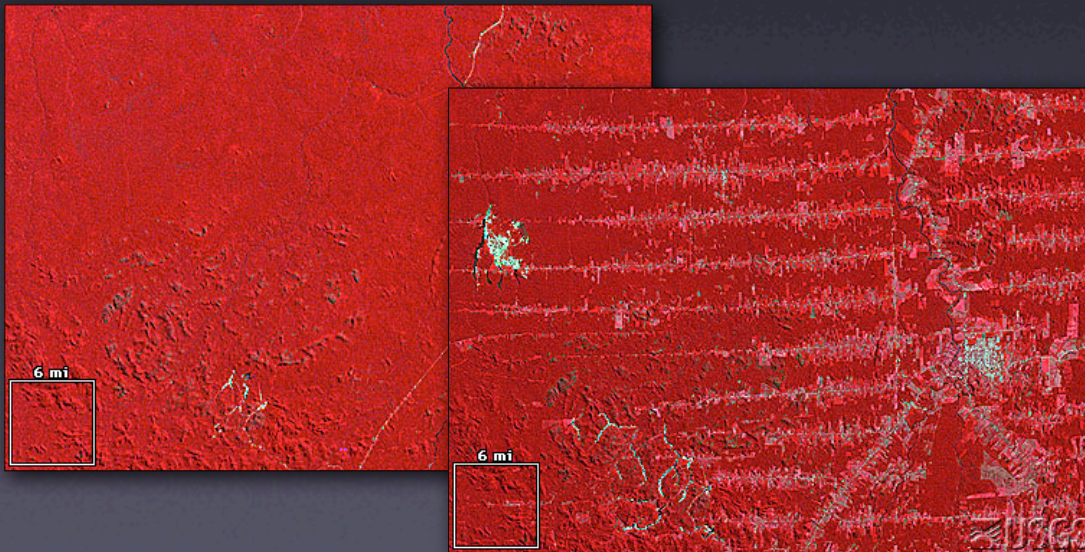
Coral Reefs

- over-harvesting fish, new diseases
- ocean warming, coral bleaching
- ocean acidification
- *lose most coral reefs by mid century?*



Tropical Forests

- deforestation
- drying forests, more fires
- wild card: global warming
- *potential for massive die off?*



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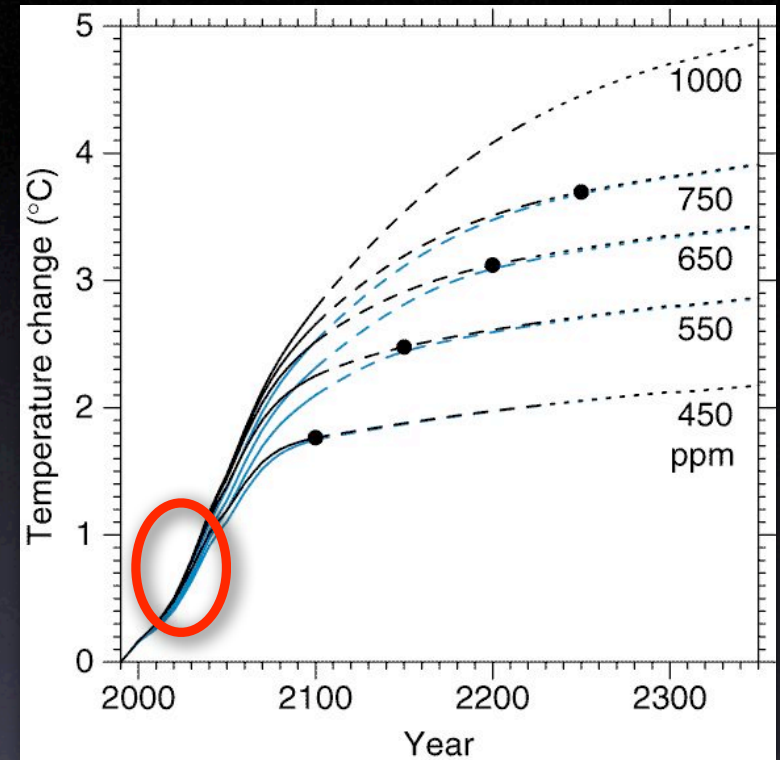
Biosphere Lost?

- threat to whole regions
 - *coral reefs, Arctic, tropical forests, ...*
- threat to whole cultures
 - *small island nations, Inuit peoples, indigenous tropical peoples, ...*
- losses will become irreversible, unless actions are taken now



Running Out of Time

- huge inertia in system
 - CO_2 in atmosphere ~ 110 years
 - “thermal lag” \sim decades
- we can’t wait and then “stop on a dime”
- narrow window to prevent catastrophic losses
 - if we’re lucky, we have a decade – maybe two



Are We Up to the Challenge?



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Image: Apple

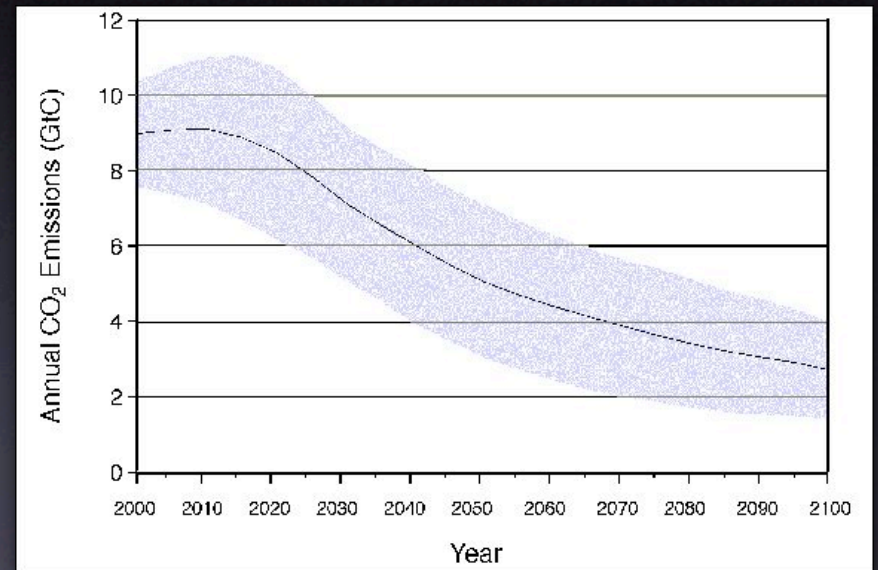
This is Going
to be *Very Hard*



Climate Stabilization is *not* a minor tweak

- “politically realistic” is not enough

- *major emissions cuts*



- stop pretending...

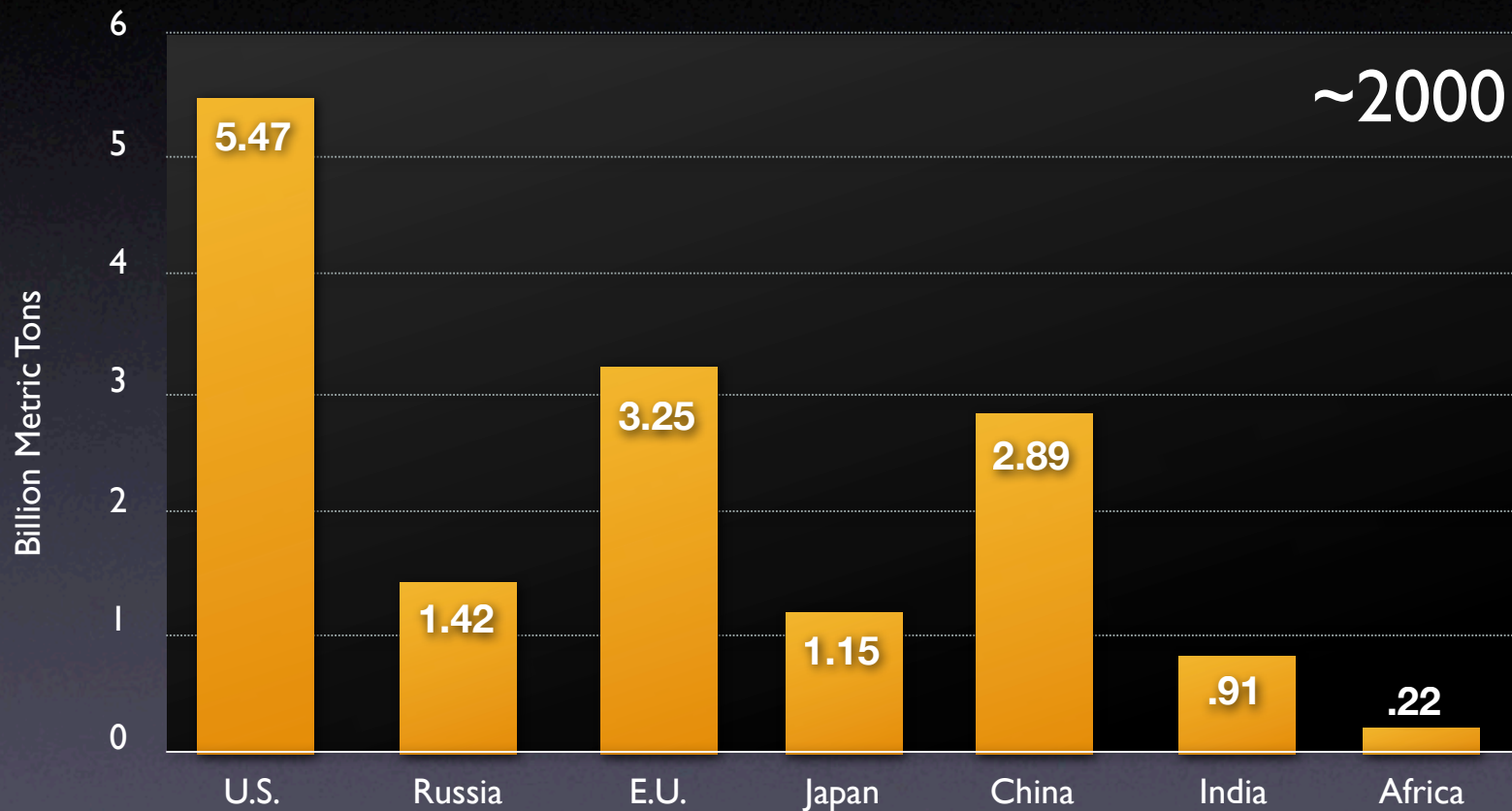
- *social & economic “realities” are fixed things*
 - *laws of physics are optional*



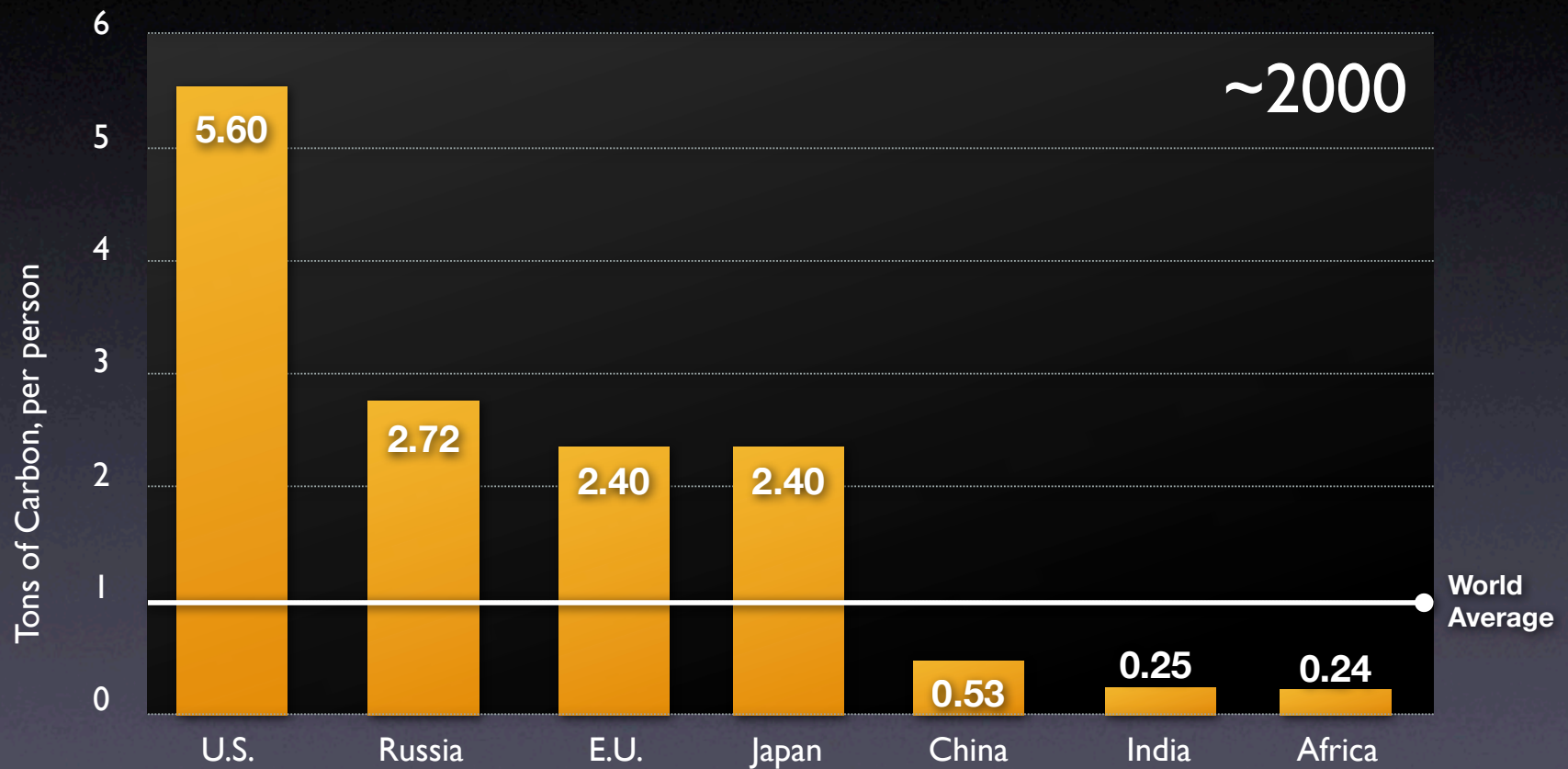
Who Needs to Act?



Carbon Emissions *by Region*



Carbon Emissions *per Person*



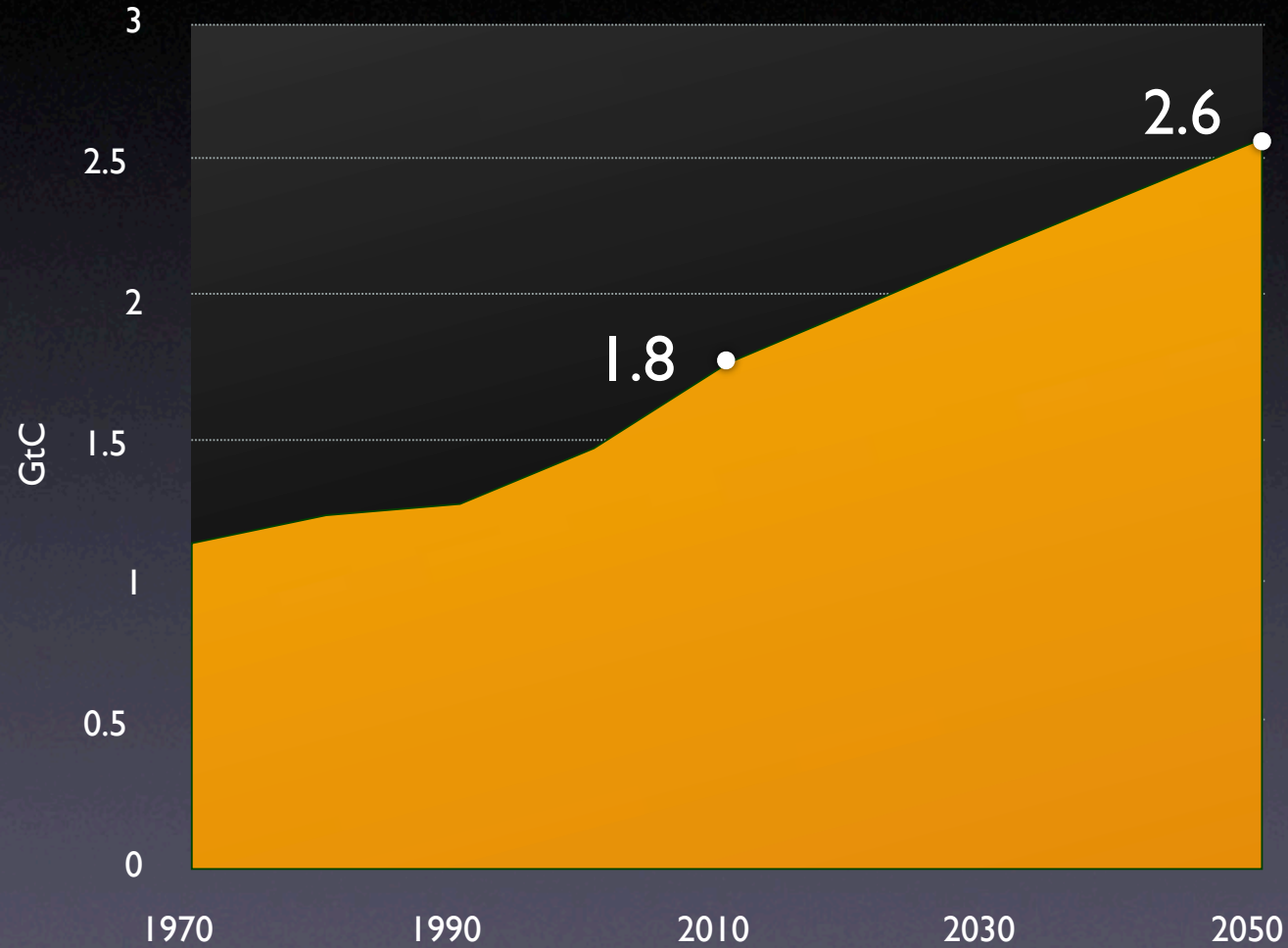
We Have the *Ability Today*



U.S. Emissions

After Pacala and Socolow, 2004;
ARI CarBen3 Spreadsheet

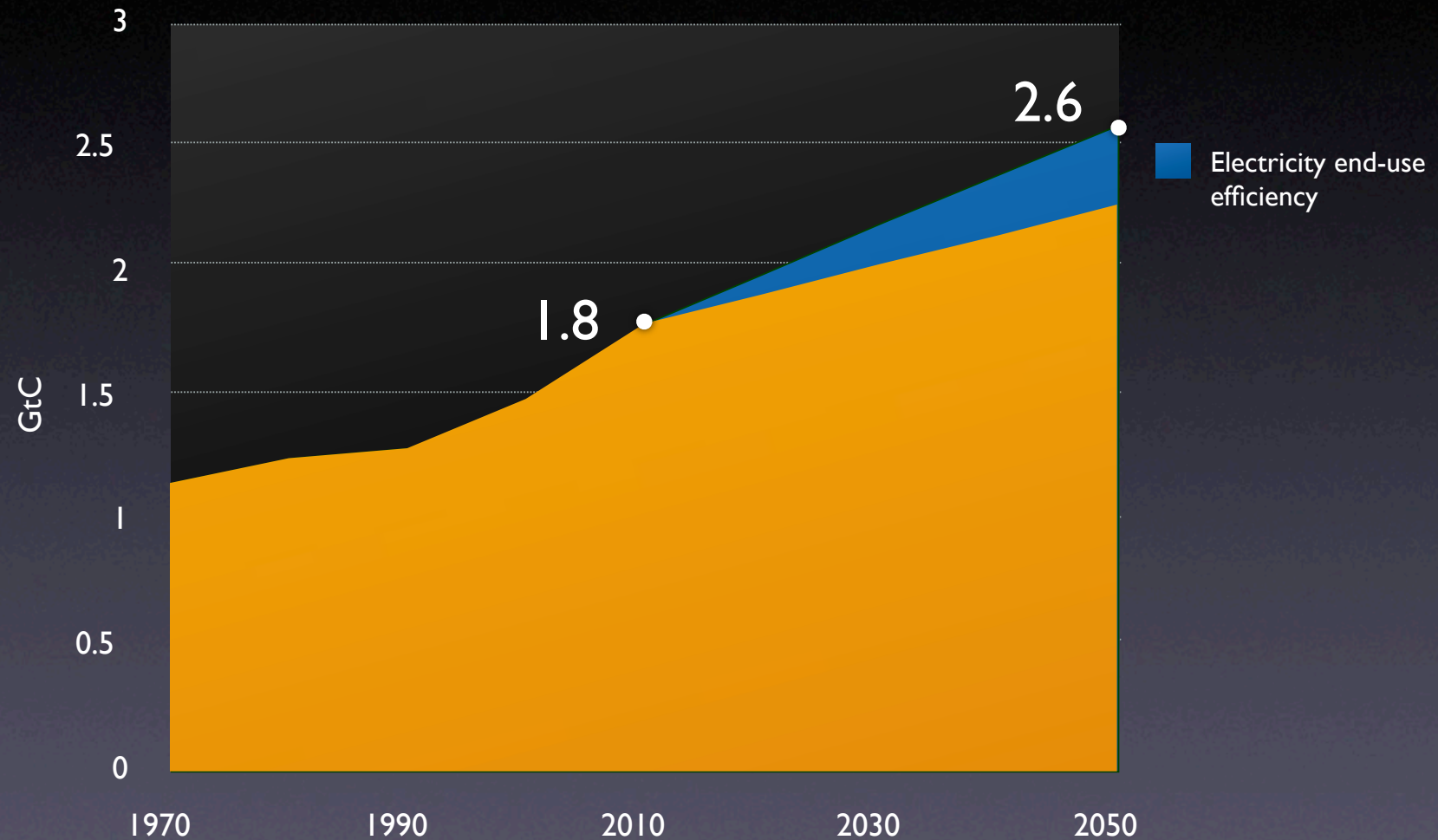
- Business as Usual



U.S. Emissions

After Pacala and Socolow, 2004;
ARI CarBen3 Spreadsheet

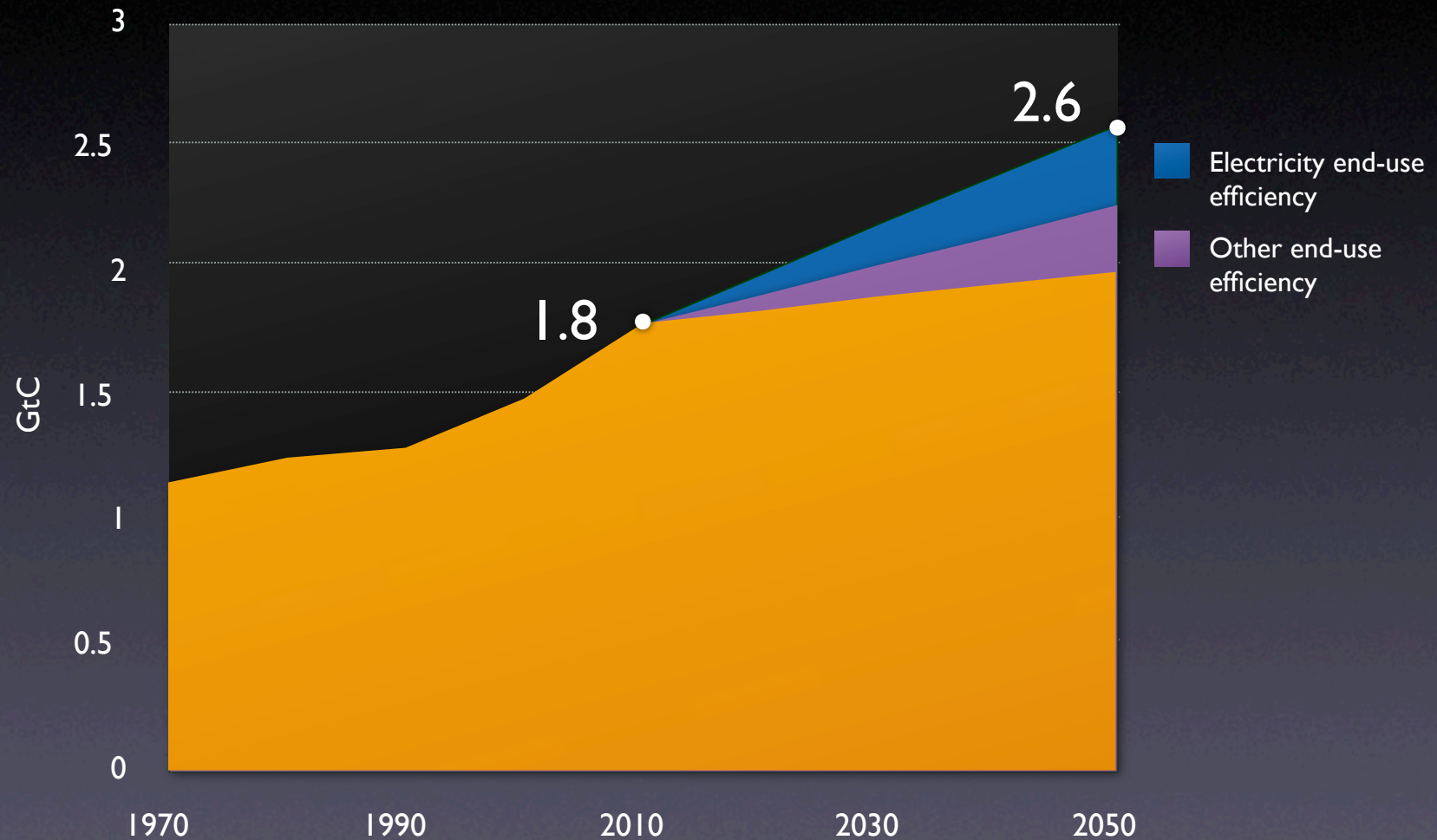
- Electrical Efficiency



U.S. Emissions

After Pacala and Socolow, 2004;
ARI CarBen3 Spreadsheet

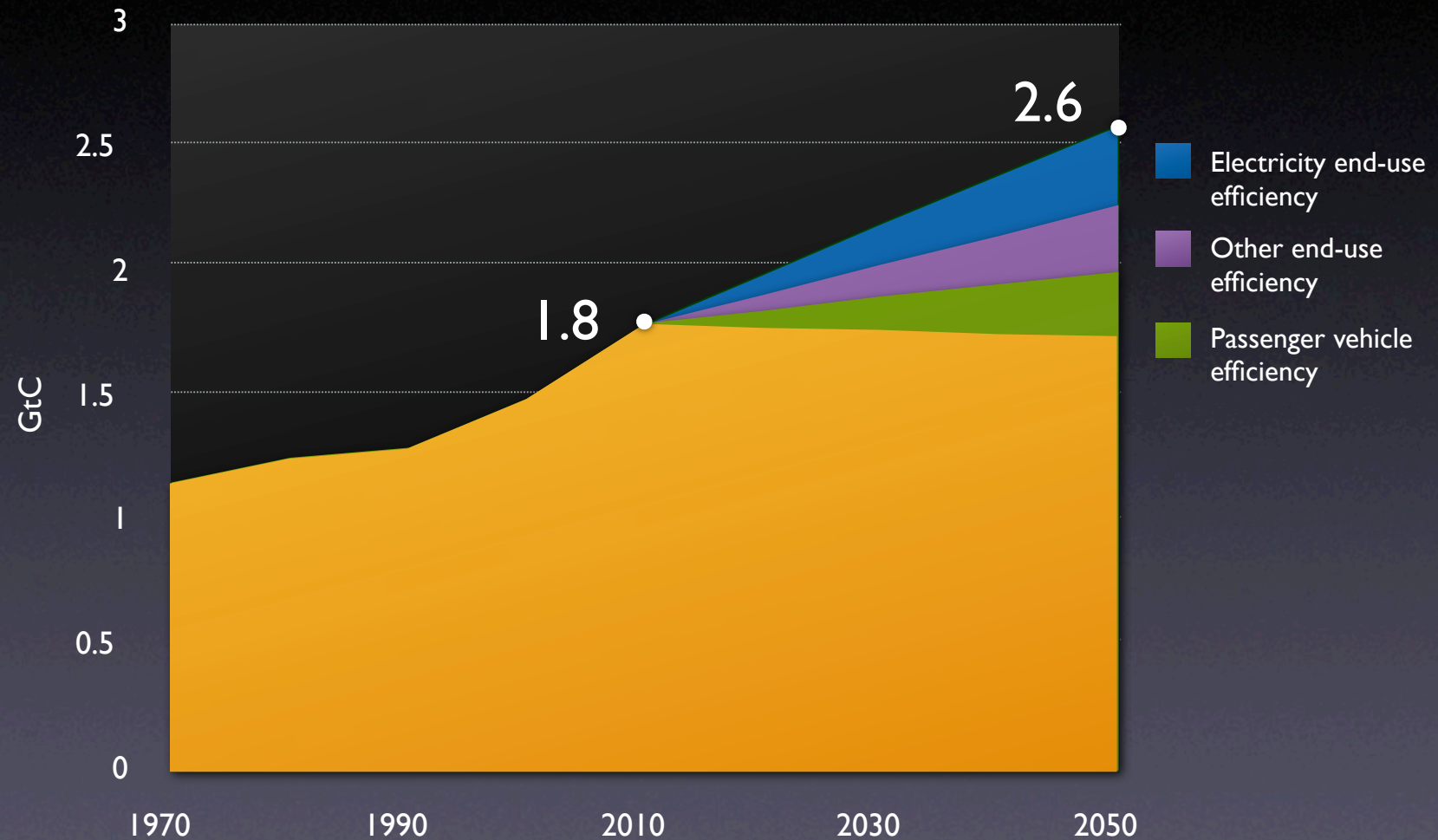
- Other End-Use Efficiency



U.S. Emissions

After Pacala and Socolow, 2004;
ARI CarBen3 Spreadsheet

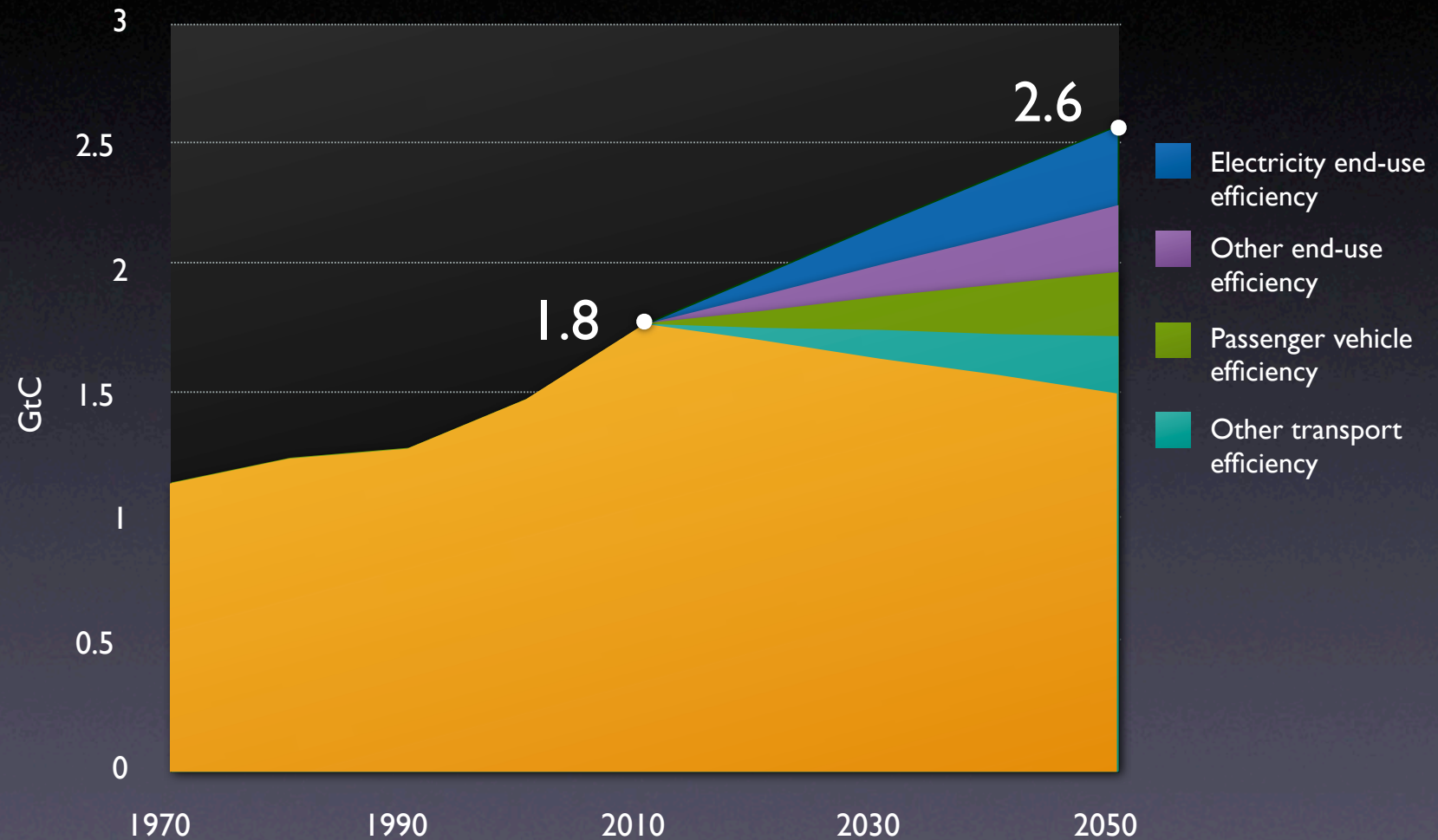
- Passenger Vehicle Efficiency



U.S. Emissions

After Pacala and Socolow, 2004;
ARI CarBen3 Spreadsheet

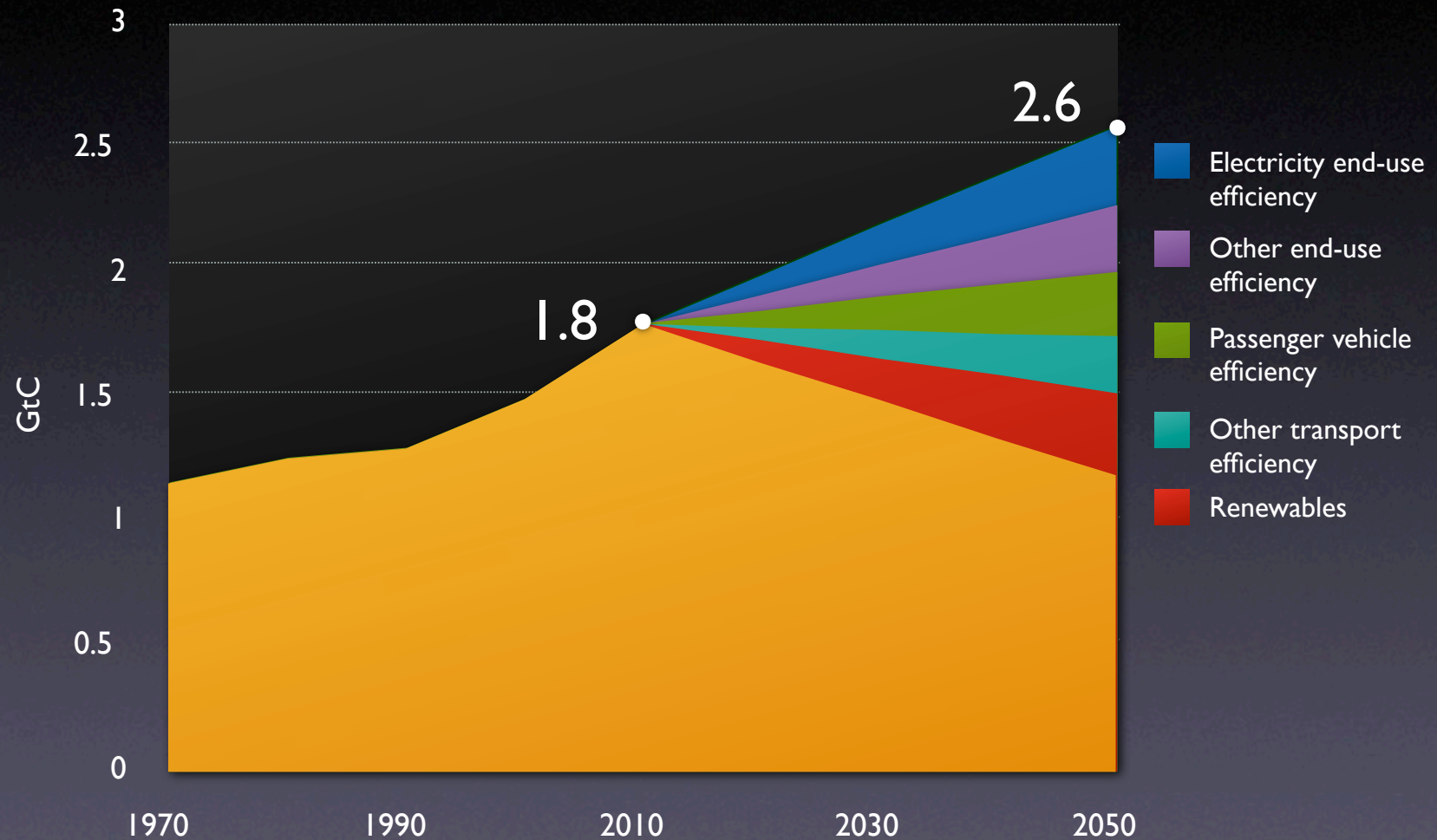
- Other Transportation Efficiency



U.S. Emissions

After Pacala and Socolow, 2004;
ARI CarBen3 Spreadsheet

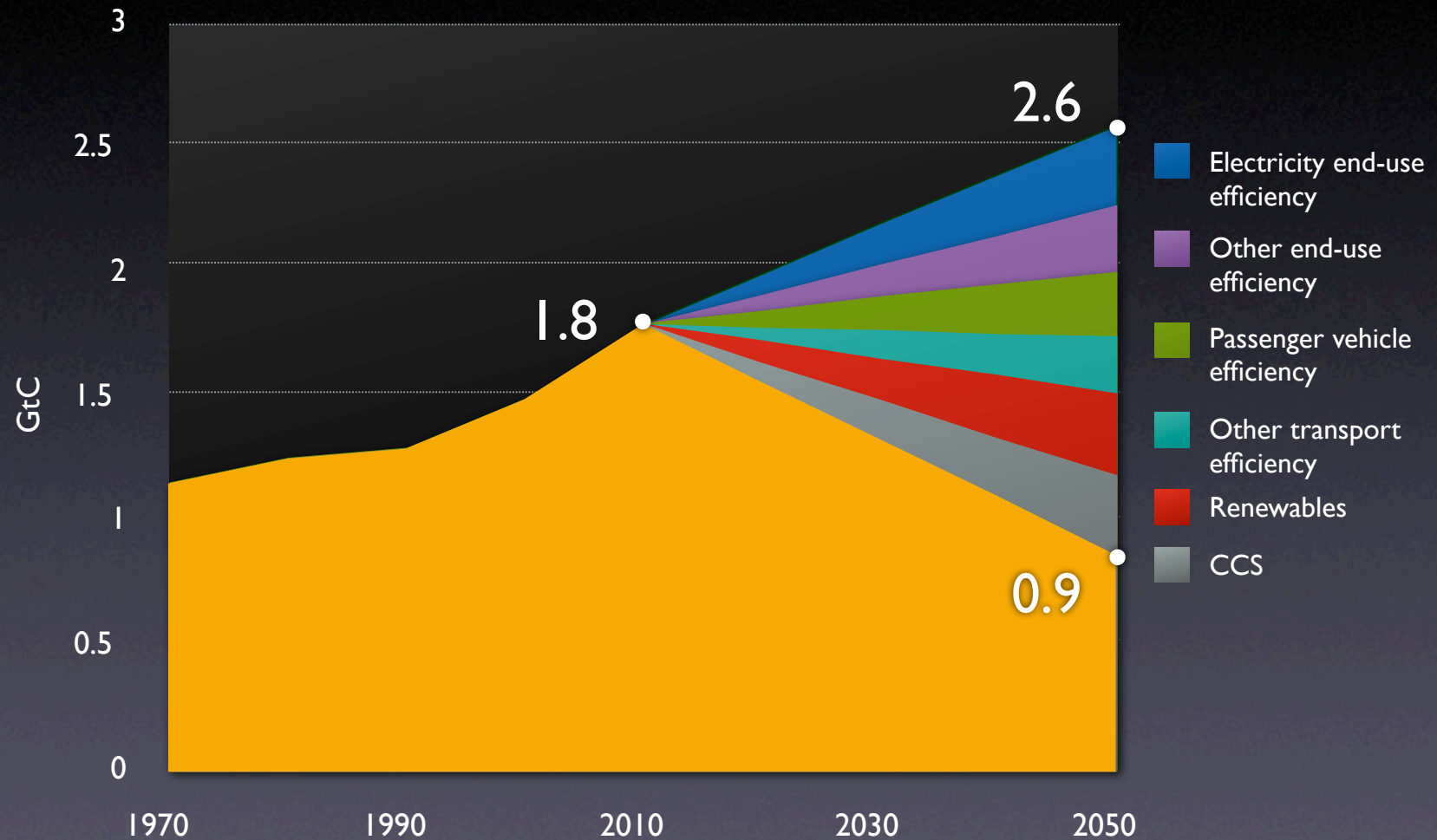
- Renewables



U.S. Emissions

After Pacala and Socolow, 2004;
ARI CarBen3 Spreadsheet

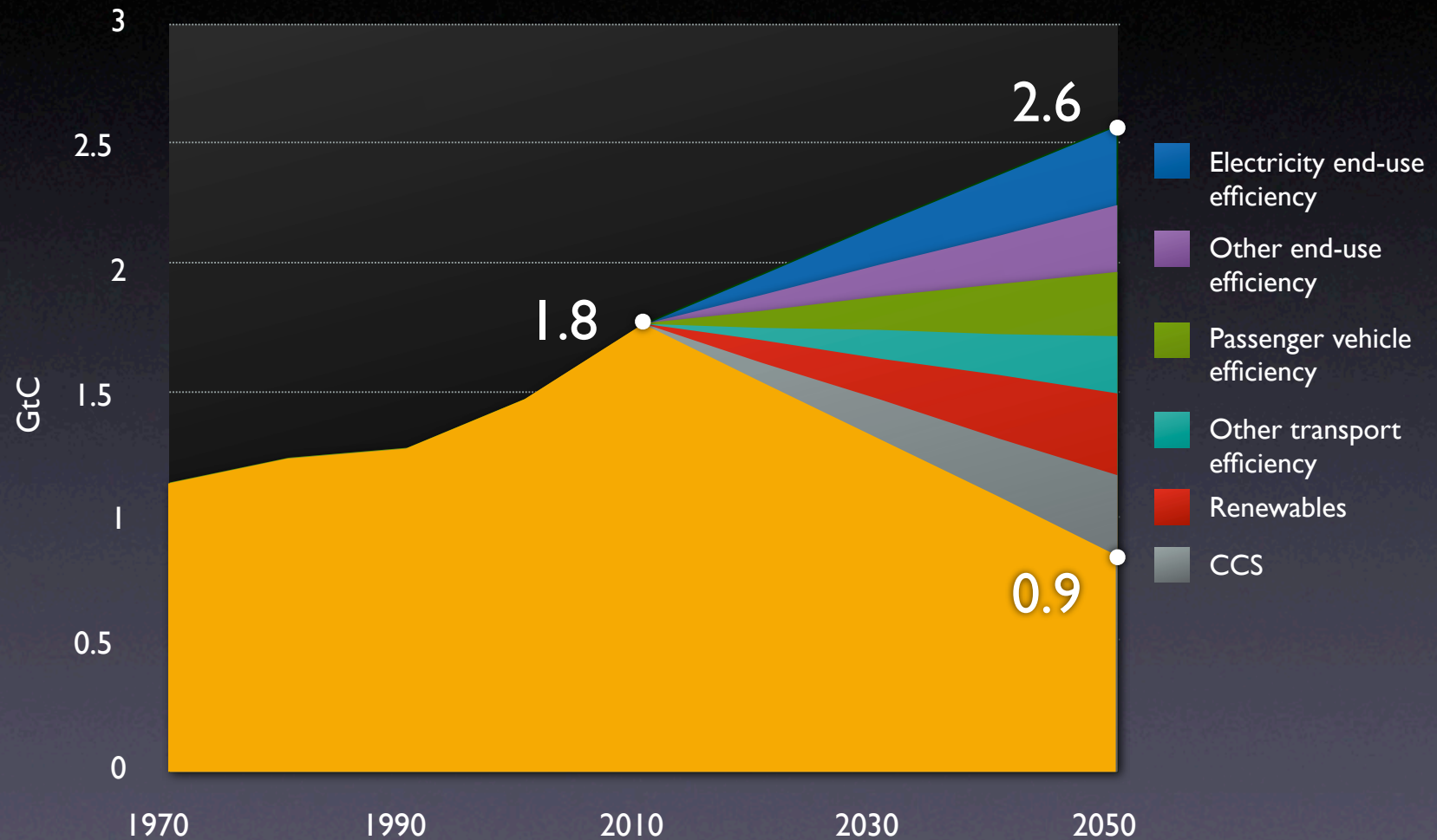
- Carbon Capture & Storage



U.S. Emissions

After Pacala and Socolow, 2004;
ARI CarBen3 Spreadsheet

- Path To U.S. Emissions Stabilization



Notice that _____ is not “THE” Solution to Climate Change

- there is no single “silver bullet”
- instead, we have “*silver buckshot*”
- many parts to the whole solution



What Can We Do in Wisconsin?



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Image: Apple

Start in Our Homes, Businesses



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University of Wisconsin, Madison

Help Homes, Businesses

- goal: cut emissions by 50%
 - *transportation*
 - *electricity*
 - *heating*
- then offset remaining emissions
 - *planting trees, prairies*
 - *conserve energy elsewhere*

we didn't meet our goal
we exceeded it

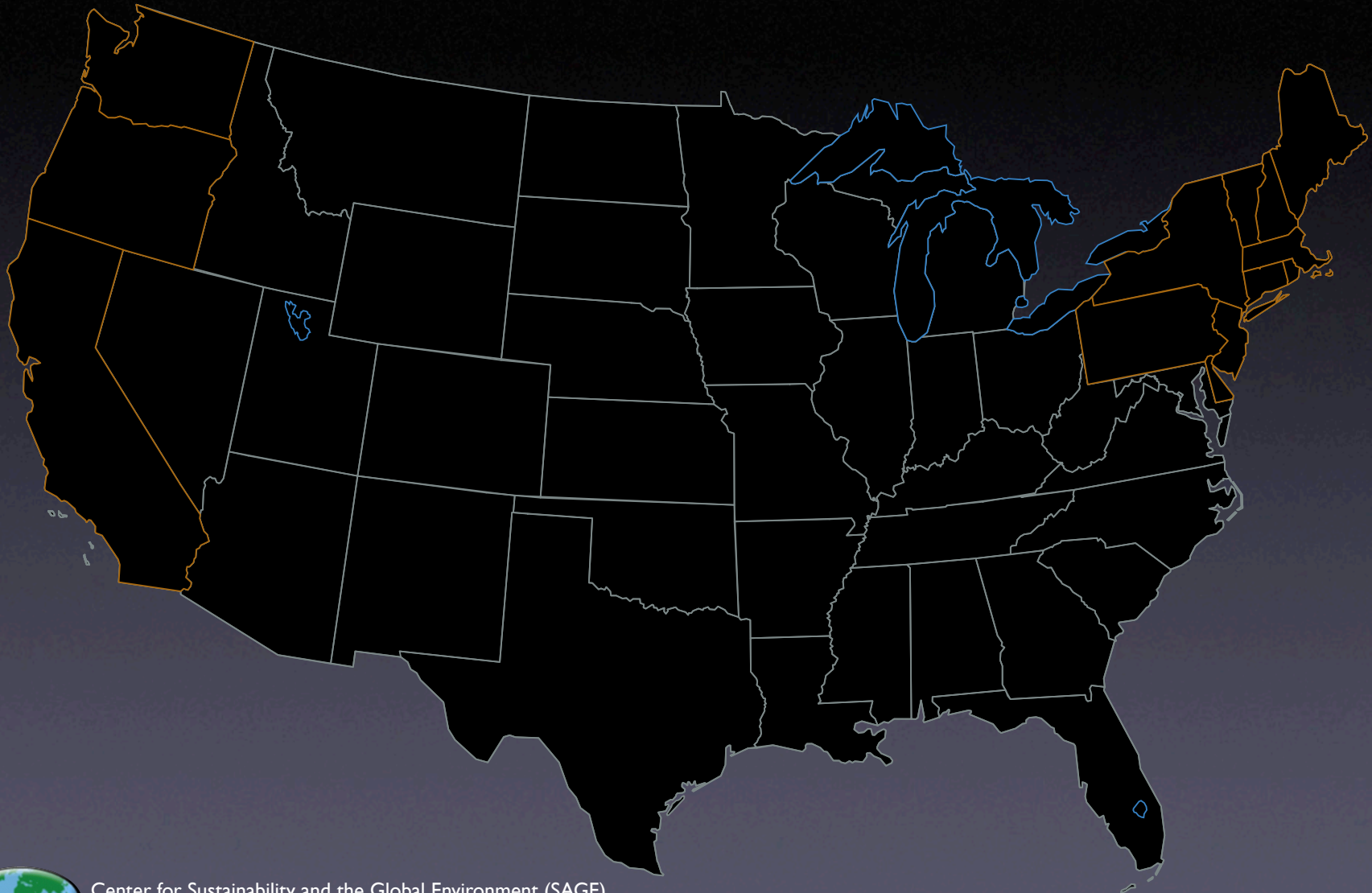


*So, how many Foley's
does it take to
change a light bulb?*

*Toyota Prius
50% less CO₂, 90% less NO_x*



Join Other State Policy Initiatives?



Be Proactive



A Challenge for Wisconsin?

- instead of just reacting to climate changes as they occur in Wisconsin
- how can we be proactive?
 - *need to start moving on the energy / emissions side*
 - *consider new legislative proposals, mirroring California laws*
 - **but also need to increase our ability to adapt to future climate changes**



This Could Be a *Huge Opportunity*



Whole New Energy Systems

- first generation renewables
 - *wind already cost-effective, solar getting there*
- new biological systems?
 - *ethanol, biodiesel*
 - *bioreactors*
- energy farms?
 - *Wisconsin: wind above, biofuel below?*
 - *Brazil: energy exporter by 2015?*



Take a *Long-Term* Perspective



Plan for the Future

- this will take time
- we need to get started now
- and we need to be in league with the future
 - *previous generations have done it*
 - *so can we!*



Plan for the Future



- New College, Oxford (c. 1386)

“...I think of the oak beams in the ceiling of College Hall at New College, Oxford. Last century, when the beams needed replacing, carpenters used oak trees that had been planted in 1386 when the dining hall was first built.

The 14th-century builder had planted the trees in anticipation of the time, hundreds of years in the future, when the beams would need replacing.

Did the carpenters plant new trees to replace the beams again a few hundred years from now?”



– Danny Hillis
Vice-President for Research and Design
Walt Disney Co.



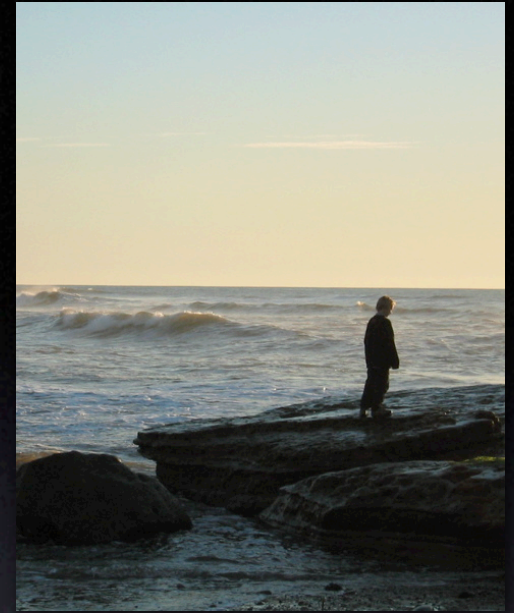
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Ultimately, This is a Moral Issue...



A Defining Moment

- what we do *now* will affect these future generations, and beyond
- we are being called upon to make choices for people yet unborn
- this is our choice...



who we are today...

...who we want to be

the world that we have...

...the world that we want



Thank You



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University of Wisconsin, Madison



But What About the “Skeptics” of Global Warming?



“The debate on global warming is over.”

Scientific American

September 2006

**“Consensus as strong as the one
that has developed around this
topic is rare in science.”**

Donald Kennedy

Editor-in-Chief, Science Magazine

**“There’s a better scientific
consensus on this than on any
issue I know, except maybe
Newton’s second law of dynamics.”**

James Baker

Administrator, NOAA

**“The threat of climate change is
clear and increasing.”**

Joint Science Academies' Statement

June 2005

“We urge all nations...to take prompt action to reduce the causes of climate change.”

Joint statement signed by the National Academies of Science in:

United States

Japan

Brazil

United Kingdom

Italy

India

France

Canada

China

Germany

Russia

Number of scientific studies dealing with “climate change” published in scientific journals during the previous ten years:

928

Number disagreeing with the global consensus that greenhouse gas pollution has caused most of the warming of the last 50 years:

0

**The misconception about the science
is an illusion deliberately created
by those who oppose government action.
Their cynical objective, as stated in a
secret memo leaked to the press, is to:**

**“Reposition Global Warming
As Theory rather than Fact.”**

Have they succeeded?

Peer-reviewed,
scientific articles:

928

Percentage in
doubt as to cause:

0%

Articles in the
popular press:

636

Percentage in
doubt as to cause:

53%

No wonder people are confused

Philip Cooney

1995—
January 20, 2001

American Petroleum Institute
Lobbyist in Charge of Global
Warming Disinformation

January 20, 2001—
June, 2005

Hired as Chief of Staff,
White House
Environment Office

The New York Times

An Editor in the White House

Environmental Quality, appear on two draft reports by the Climate Change Science Program on Global Change Research. Mr. Cooney's changes were incorporated into later versions shown below with revisions in bold.

"STRATEGIC PLAN FOR THE U.S. CLIMATE CHANGE SCIENCE PROGRAM," DRAFT TEXT, OCT. 2002

~~Warming will also cause reductions in mountain glaciers and advance the timing of the melt of mountain snow peaks in polar regions. In turn, runoff rates will change and flood potential will be altered in ways that are currently not well understood. There will be significant shifts in the seasonality of runoff that will have serious impacts on native populations that rely on fishing and hunting for their livelihood. These changes will be further complicated by shifts in precipitation regimes and a possible intensification and increased frequency of extreme hydrologic events. Reducing the uncertainties in current understanding of the relationships between climate change and Arctic hydrology is critical~~

straying from research strategy into speculative findings findings here.

020 The challenge for the USGCRP is to provide the best possible scientific basis for documenting, *understanding*
021 ~~diagnosing~~, and projecting changes in the Earth's life-support systems, and the role for CCRI is to
022 facilitate full use of ~~this~~ scientific information in policy and decisionmaking on response strategies
023 for adaptation and mitigation at the international, national, and regional scales. *possible*
024
025
026 *might allow* From "Discovery" to "Comparative Analysis" *reduce the significant*
027 *persuaded* *remaining uncertainties*
028 Because of the scientific accomplishments of USGCRP and other research programs during the *associated with human-*
029 last decade, a period that could be termed a productive "period of discovery and characterization," *induced*
030 the CCRI, in coordination with the USGCRP, will move into a new "period of comparative *climate*
031 analysis of response strategies." In this new phase of the climate science programs, information *change*
032 that compares the potential consequences of different responses to global changes, including *and*
033 climate change, will be *developed in a form useful to national debate and decisionmaking. This*

FINAL REPORT, 2003

The challenge for the USGCRP is to provide the best possible scientific basis for documenting, **understanding**, and projecting changes in the Earth's life-support systems, and the role for CCRI is to **reduce the significant remaining uncertainties associated with human-induced climate change** and facilitate full use of scientific information in policy and decisionmaking on **possible** response strategies for adaptation and mitigation.

The New York Times

Philip Cooney

1995—
January 20, 2001

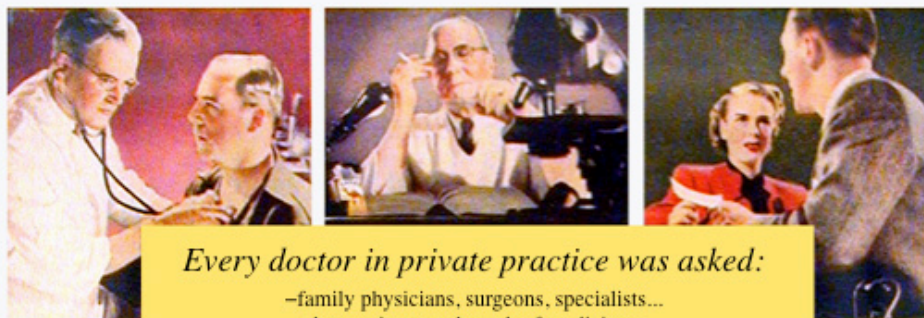
American Petroleum Institute
Lobbyist in Charge of Global
Warming Disinformation

January 20, 2001—
June, 2005

Hired as Chief of Staff,
White House
Environment Office

June 14, 2005

Leaves White House to go on
payroll of Exxon Mobil



Every doctor in private practice was asked:

*—family physicians, surgeons, specialists...
doctors in every branch of medicine—*

“What cigarette do you smoke?”



According to a new Nationwide survey:

More Doctors Smoke Camels

than any other cigarette!

**not a guess, not just a trend . . . but an actual fact based on
the statements of doctors themselves to 3 nationally
known independent research organizations.**

**THE
“T-ZONE” TEST
WILL
TELL YOU**



The “T-Zone” — T for taste and T for throat — is your own laboratory, your proving ground, for any cigarette. For only your taste and your throat can decide which cigarette tastes best to you . . . and how it affects your throat. On the basis of the experience of many, many millions of smokers, we believe Camels will suit your “T-Zone” to a “T.”



B. J. Reynolds Tobacco Co.

YES, your doctor was asked . . . along with thousands and thousands of other doctors from Maine to California.

And they’ve named their choice — the brand that more doctors named as their smoke is *Camel*! Three nationally known independent research organizations found this to be a fact.

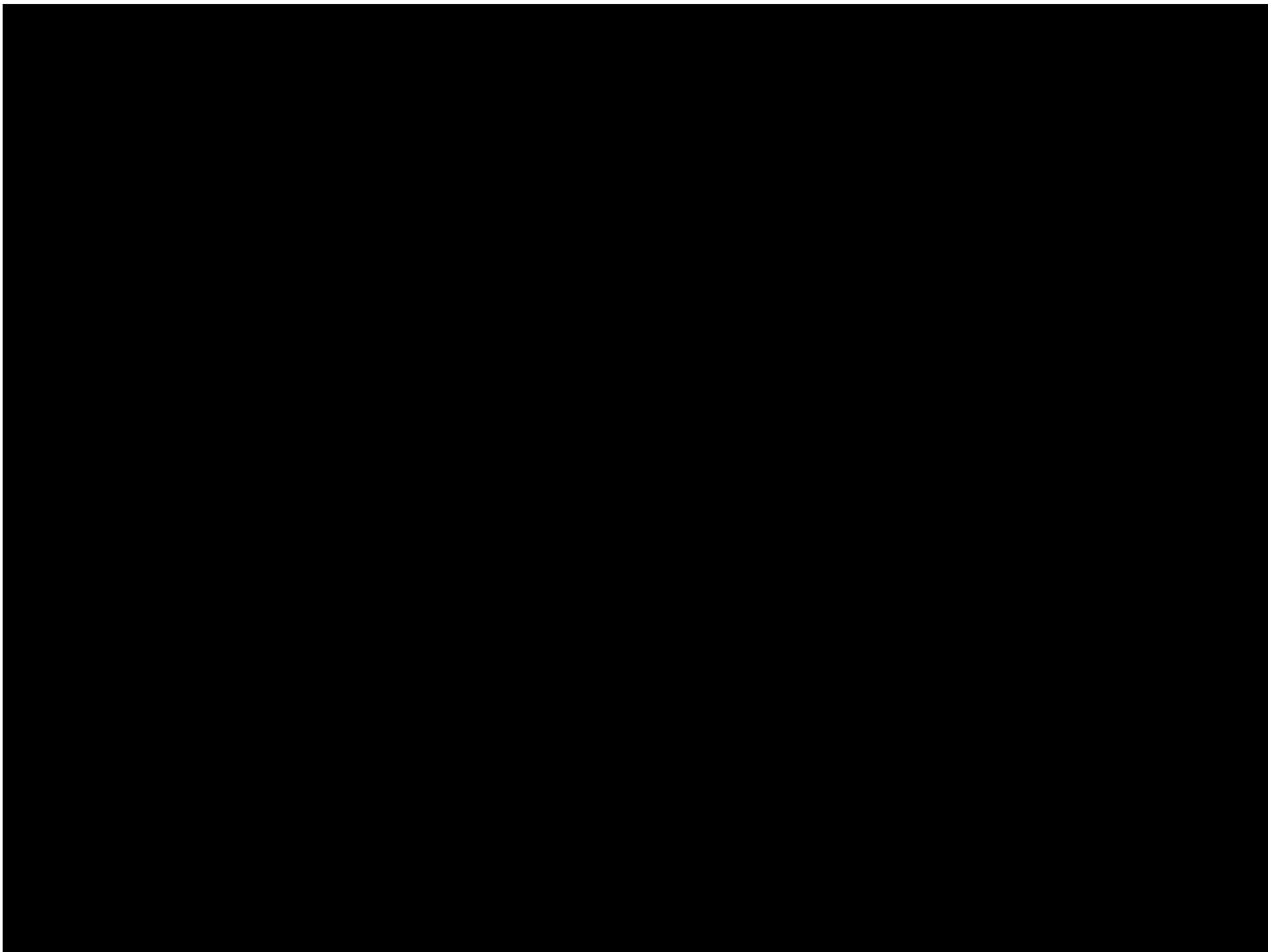
Nothing unusual about it. Doctors smoke for pleasure just like the rest of us. They appreciate, just like you, a mildness that’s cool and easy on the throat. They too enjoy the full, rich flavor of expertly blended costlier tobaccos. Next time, try Camels.

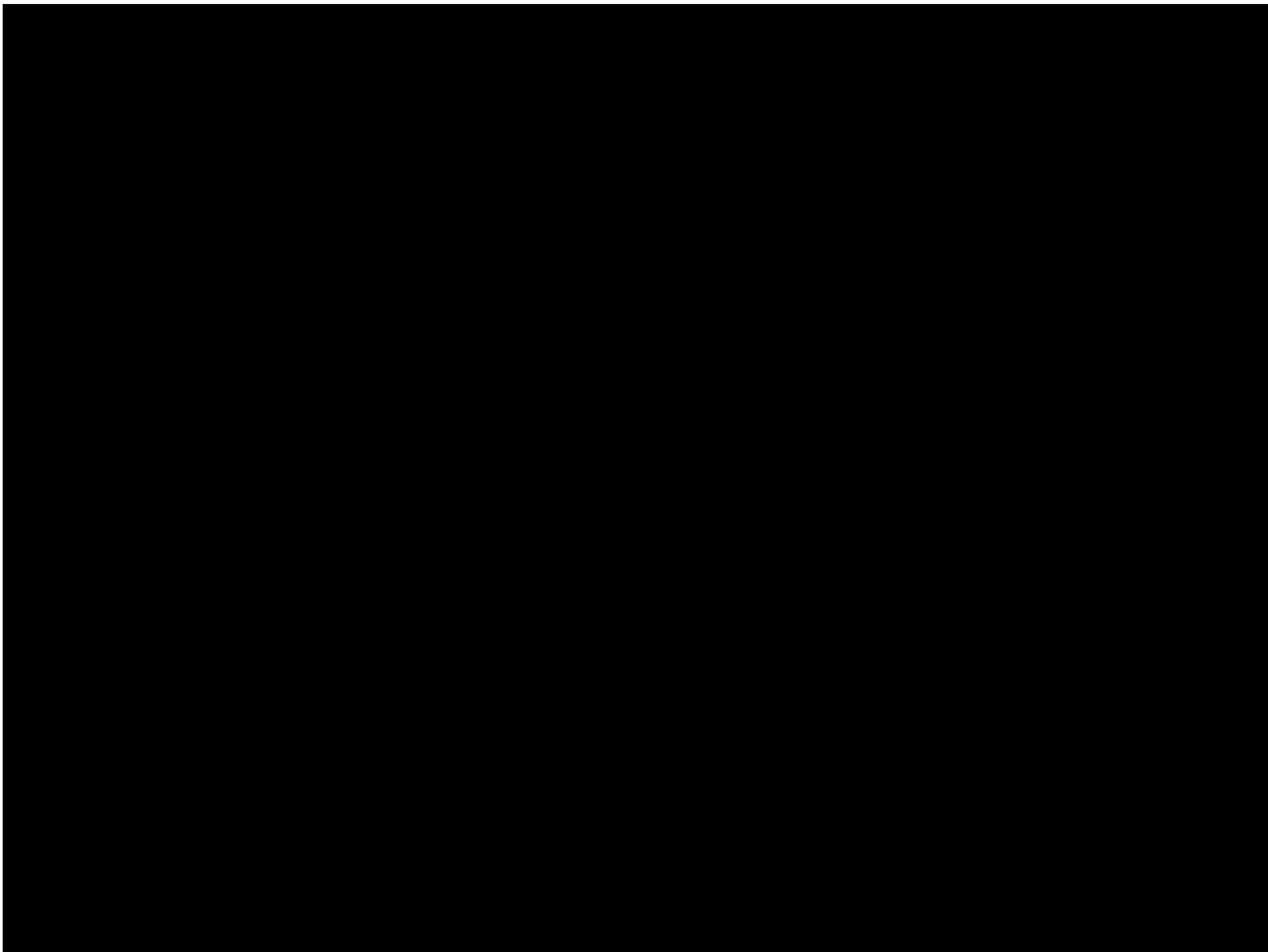
“Doubt is our product, since it is the best means of competing with the ‘body of fact’ that exists in the mind of the general public. It is also the means of establishing a controversy.”

Brown and Williamson

Tobacco Company memo

1960s







Global Warming

*One Symptom of a
Larger Disease*



A Planet Pushed to the Limits



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University of Wisconsin, Madison

Other Symptoms? Consider *Industrial Agriculture*



Image: NASA, ASTER Science Team

Minnesota

Kansas

Germany

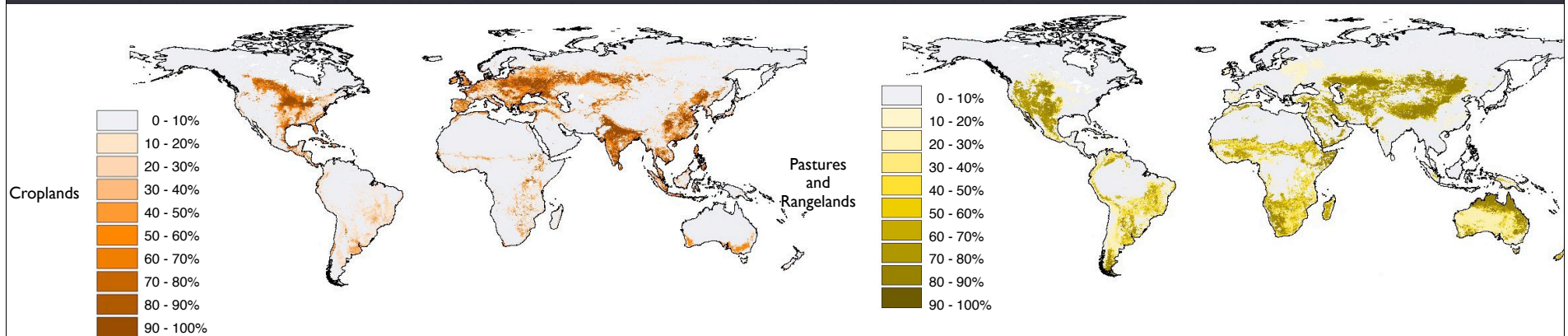
Bolivia

Thailand

Brazil

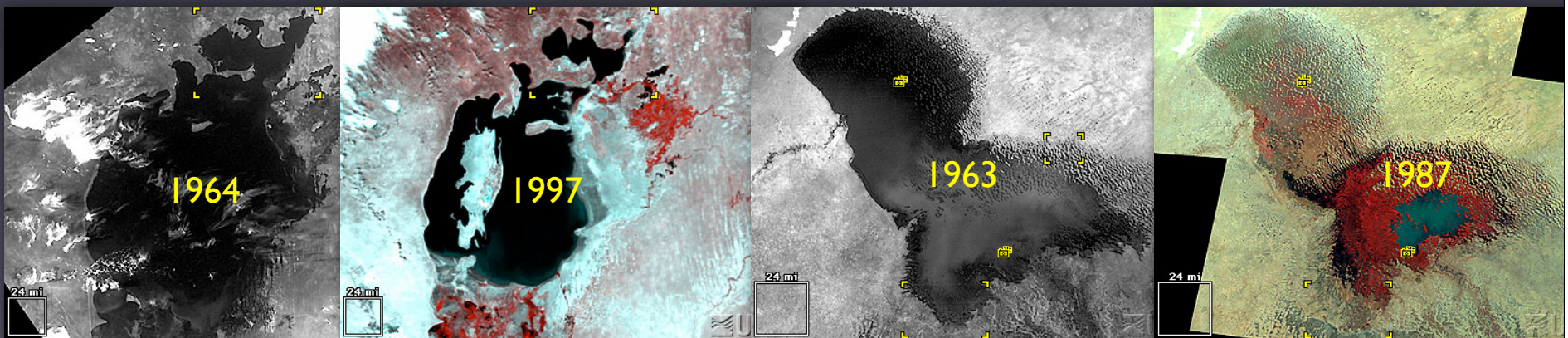
I) Land Degradation

- massive changes to Earth's land
 - ~40% of land converted to agriculture, cities
 - 18 million km² in crops
 - 30 million km² in pastures, rangeland
 - 5 million km² in concrete
 - and ~80% of land has human disturbance
- today, ~40% of global photosynthesis now in human hands



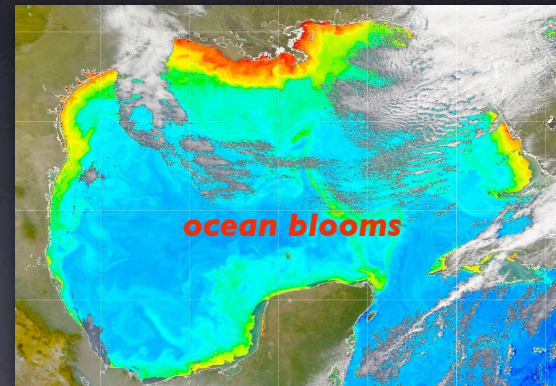
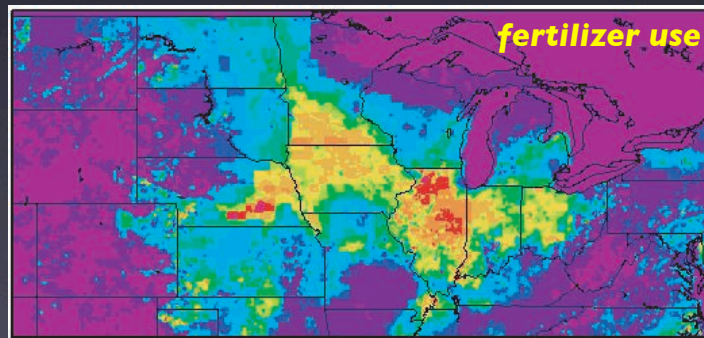
2) Water Degradation

- massive increases in water use
 - water use tripled in 50 years
 - mostly due to agriculture
 - 70% irrigation, 20% industry, 10% domestic
- ~50% of available freshwater flow already co-opted
 - result: dry rivers, groundwater depletion



3) Excess Nutrient Pollution

- massive release of excess nutrients
 - doubling natural nitrogen, phosphorus flows
 - *polluted lakes and rivers*
 - coastal “dead zones”



Hypoxic zone,
mid-July,
1999



Source: N. Rabalais (LUMC)



It's *All* Hitting
the Fan...
....at the
Same Time



“Here’s what I’ve decided: the very least you can do in your life is figure out what you hope for…”

What I want is so simple I almost can’t say it: elementary kindness.

Enough to eat, enough to go around.

The possibility that kids might one day grow up to be neither the destroyers nor the destroyed.

That’s about it.”

**- Barbara Kingsolver,
Animal Dreams**



Seeing Earth as *One Place*...



Center for Sustainability and the Global Environment (SAGE)
University of Wisconsin, Madison

Seeing Earth as *One Place*...



Source: NASA, Goddard Space Flight Center



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“May You Live in Interesting Times...”

- Ancient Chinese Curse

